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ECONOMIC GEOGRAPHY

JANUARY

ALABAMA BLACK BELT: ITS GEOGRAPHIC STATUS
J. Sullivan Gibson

UNITED STATES FLAX INDUSTRY
George H. Primmer

INDUSTRIAL AREA OF NEWCASTLE, AUSTRALIA
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O. H. Spate

PHOSPHATE LANDS OF TENNESSEE
H. Thompson Straw

CLARK UNIVERSITY, WORCESTER, MASSACHUSETTS, U.S.A.

OUR CONTRIBUTORS

Dr. Gibson, head of the Geography Staff at State Teachers College, Livingston, Alabama, received his Ph.D. from the Clark Graduate School of Geography. Before taking his present position he was Geographer and Cartographer on the Scientific Staff of the Tennessee Valley Authority. His training in land utilization, and extensive work in that field in the South, particularly in Kentucky, Tennessee, and Alabama, have equipped him for the type of work which his present article represents.

Dr. Primmer is known to readers of ECONOMIC GEOGRAPHY, to which he has previously contributed several articles. He is a Ph.D. from the Clark Graduate School of Geography, and has taught as assistant in the Department of Geography at the University of Chicago, as teacher of Geography at Duluth State Teachers College, and finally in his present position as head of the Department of Geography there.

Dr. Zierer, Ph.D. from the University of Chicago, is Associate Professor at the University of California at Los Angeles. He is particularly interested in Urban and Industrial Geography, and has written numerous articles dealing with those subjects which have appeared in various geographic journals. His present article is one of a series which he is preparing as a result of a six months' stay in Australia in 1937, studying its major cities.

Dr. Culbert received his A.B. from the University of Minnesota, and his A.M. and Ph.D. from the Clark Graduate School of Geography. He taught at Alabama Polytechnic Institute during the summer of 1939, at Baylor University, Waco, Texas, during the summer of 1940, and is at present teaching in Taos, New Mexico.

Mr. Ackerman, a graduate of Harvard, is now assistant in the Department of Geology and Geography of his Alma Mater. Two of his articles have appeared in earlier issues of ECONOMIC GEOGRAPHY, the latest, "Depletion in New England Fisheries," in the July, 1938, issue.

Dr. Spate, Lecturer in Geography at University College, Rangoon, was Scholar in Geography in St. Catharine's College, Cambridge, where he took First Class in the Geography Honours School, and received his Ph.D. in 1937. He is primarily interested in historical geography, having contributed the chapter on 18th Century London in *Historical Geography of England and Wales*, edited by Dr. H. C. Darby and issued from the Cambridge University Press.

Dr. Straw received his A.M. and Ph.D. degrees from the University of Michigan. He has taught geography since 1935, and is at present Professor of Geography at Western State Teachers College, Kalamazoo, Michigan. Several of his articles have appeared in scientific journals; his present article is one of a series to be written on the southeastern part of the United States.

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THE SOUTH

THE South is the most distinctive, from almost every point of view, of all the major regions of our country. The High Plains, the Midwest, the Far West, the Lake States, New England—all these bring to mind distinctive attributes, regionally aggregated, of physical background, of industrial and agricultural systems, of man's economies and social struggles; but none suggests such definite distinctions, such inherent characteristics as does The South.

The South is distinctive in its climate, its soils, its coastal contour; in its crops, its farm types, and its rural economy and society; in the composition of its population; in its prejudices, its problems, its points of view; in its political development and its history; and most of all in the way of living of its folk. It emphasizes these distinctions and prides itself upon them, sometimes to its own hurt.

Yet The South is as essentially American, as loyally active in the affairs of our nation, as patriotic and devoted in its citizenship, as effective in national councils and national purposes, as any part of the country. It is one of the vital factors that makes America powerful and respected throughout the world. It complements in some measure, in some significant relationship, every other similar region of our land, and plays its important rôle in the integrity of our sovereignty and the progress of our people toward a higher civilization, a richer culture. Like all the rest of the major regions of our country it is indispensable to our national sufficiency, our national unity.

ECONOMIC GEOGRAPHY

VOL. 17 JANUARY, 1941 No. 1

THE ALABAMA BLACK BELT: ITS GEOGRAPHIC STATUS

J. Sullivan Gibson

TO the geographer as well as to many other scientists and laymen the term Black Belt bears a definite association with the dark prairie soil of south central Alabama. Many misconceptions regarding the origin of the name have arisen from loose usage. Some popularly assign the high proportion of negro population; others disregard as regional identities the human factors, both racial and cultural; still others think of the region as being much more extensive than it is. Although many economic, social, and cultural factors have entered in to complicate the region's identity, geographic boundaries closely approximate the limits of the Selma chalk underlying the black prairie soil. For purposes of geographic interpretation the Black Belt may be considered as coinciding with the Selma chalk crescent.

The long-conceded regional identity of the Black Belt roots no more deeply in its physical fundament of rolling prairie soil than in its cultural, social, and economic individuality. Narrow cultural transition zones, counterparts of sharp geologic and soil boundaries, separate the Black Belt from adjacent regions contrasting in physical character, land use practices, and racial composition.

The plantation system of cotton culture proved an appropriate adjustment to Nature's resources in early days, and upon this adjustment has evolved a culture even more individualistic than is the soil upon which it rests. This regional identity, therefore, reaches far beyond the scope of geography. Indeed, the geographical factors act less forcefully today than do factors of custom, race, and tradition. Many geographic relationships of a century ago no longer exist; whereas, numerous custom-fixed, traditional practices, contradictory to geographical principles, have resulted in serious maladjustments definitely characteristic of the region.

The Black Belt of today reflects a past more renowned than its present, and much of its individuality represents a heritage of better days (Figure 2). An agrarian economy rooted in scattered, rolling tracts of prairie soils of unusual pristine richness gave distinction to early society. Slave labor yielded profits to a sparse white population. In early post-slavery decades, a tenant system supplanting the older order perpetuated the prestige of the

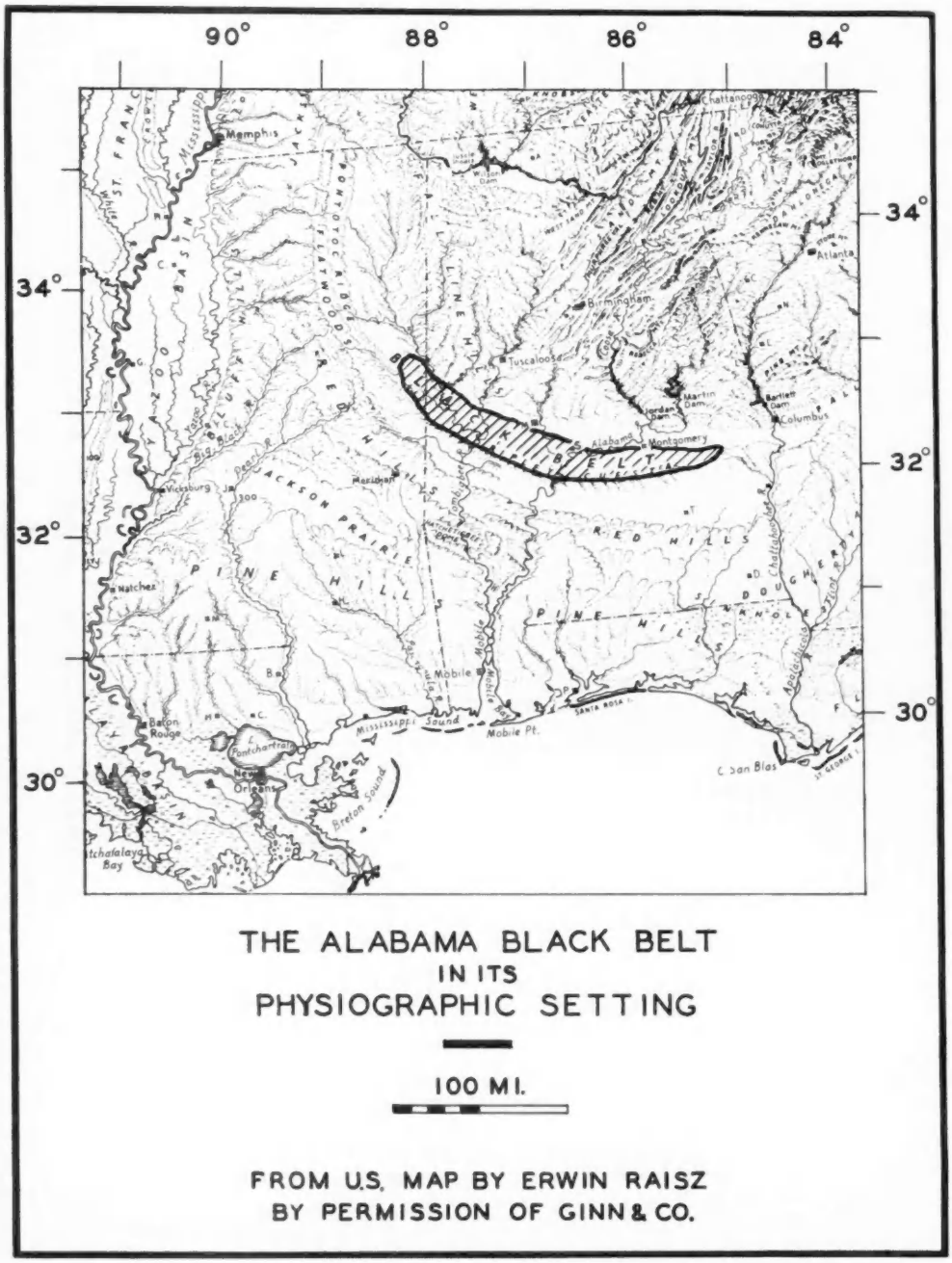

FIGURE 1.—Southwestward from the crystalline oldland of the Southern Appalachians the Black Belt extends in crescent shape from eastern Alabama westward into Mississippi. The region is identified almost entirely with Alabama, embracing an area of nearly 5,000 square miles in that state. Developed on consolidated but weak Selma chalk which continues as a narrow band northward through eastern Mississippi, the Black Belt lowland possessed at time of settlement rich calcareous soils fertilized by native prairie grasses. Southward the belted Gulf coastal plain extends its rolling topography with less fertile, sandy soils and associated pine forests, much of which axe and fire have removed.

cotton planter. More recently, soil deterioration, the decline of the cotton crop, and the exodus of many farmers, both white and negro, have resulted in economic and cultural decline.

GEOLOGIC AND PHYSIOGRAPHIC IDENTITY

Three relatively well-defined, semi-concentric cuestas, together with their related lowlands, comprise the belted coastal plain of Alabama and eastern Mississippi (Figure 1). The Chunnenuggee cuesta (also mapped as Ripley cuesta, Pontotoc ridge, and four upper Cretaceous formations—Ripley, Selma, Eutaw, and Tuscaloosa—present in Alabama (Figure 3). This chalk formation, formerly mapped as Rotten Limestone, disintegrates rapidly and relatively uniformly under normal processes of surface erosion, although it is too impure for percolating water to form sinks, caves, etc., common to many limestone regions.

Inland from the chalk, Eutaw and Tuscaloosa formations of unconsolidated clays, sands, and gravel stand up under erosion somewhat better than does the Selma chalk, although the latter is

FIGURE 2.—These stately old landmarks, many of which remain throughout the Black Belt, evidence a more prosperous and more renowned period than the present. Fires claim some annually; whereas, dwindled bank accounts and exchange of ownership have allowed many to fall into bad repair. In the complete absence of building stone, virgin yellow pine furnished the region building timber far superior to any now available.

A. This country residence, built about 1840, represents the type of architecture characteristic of the pre-Civil War period. In the absence of basement and furnace, open fireplaces (eight of which serve this building) feed from wood lots and timbered bottom lands.

B. This house similar to the one shown in A, was built in the 1830's, and has remained in constant use and in good repair. These two homes are in the vicinity of Livingston, Sumter County.

perhaps bearing other local names), innermost of the three, incloses the Black Belt lowland crescent. Belonging to the Ripley (uppermost Cretaceous) formation, this cuesta, in its eastern part, in places presents a bold escarpment attaining a height of 100 feet or more. But for the most part, only broken hill country prevails, with softened contour and slight elevation in places minimizing any topographic contrasts with the region it incloses.

The lowland within the cuesta has developed on the beveled surface of Selma chalk, second youngest of the much more consolidated. These sediments form broken hill country with higher elevation and greater relief than the area of Selma chalk in the western part of the state. In the eastern part, however, before entering the Selma chalk near the town of Selma, the Alabama River flows as a subsequent stream through a broad lowland valley developed on the Eutaw formation as the river stripped away the overlying chalk. This lowland, which varies in width from three to ten miles, lies somewhat below the upland level of

the Black Belt and parallels it for a distance of 75 miles or more.

The Black Belt proper, when confined to the Selma chalk, comprises less than one-half the area lying between the Chunnennuggee cuesta and outcrops of Pennsylvanian and other older rocks farther inland. With an area of approximately 5,000 square miles and an average width of about 20 miles the crescent extends from a point 60 miles east of Montgomery westward into Mississippi.

In eastern Alabama, Tuscaloosa and Eutaw formations rest directly upon the crystalline oldland. Westward, however, folded and broken carboniferous sediments of the Great Appalachian Valley and nearly horizontal layers of comparable age belonging to the Appalachian Plateau, dip beneath the Cretaceous formations. Thus, the Selma chalk normally does not have contact with the crystalline oldland. Only in the east do the two formations approach each other, and there they are separated by a broad river valley and by several miles of sand and gravel hill country. In consideration of the geologic and topographic relationships between the Selma chalk and neighboring regions the true inner-lowland character of the Black Belt appears questionable.

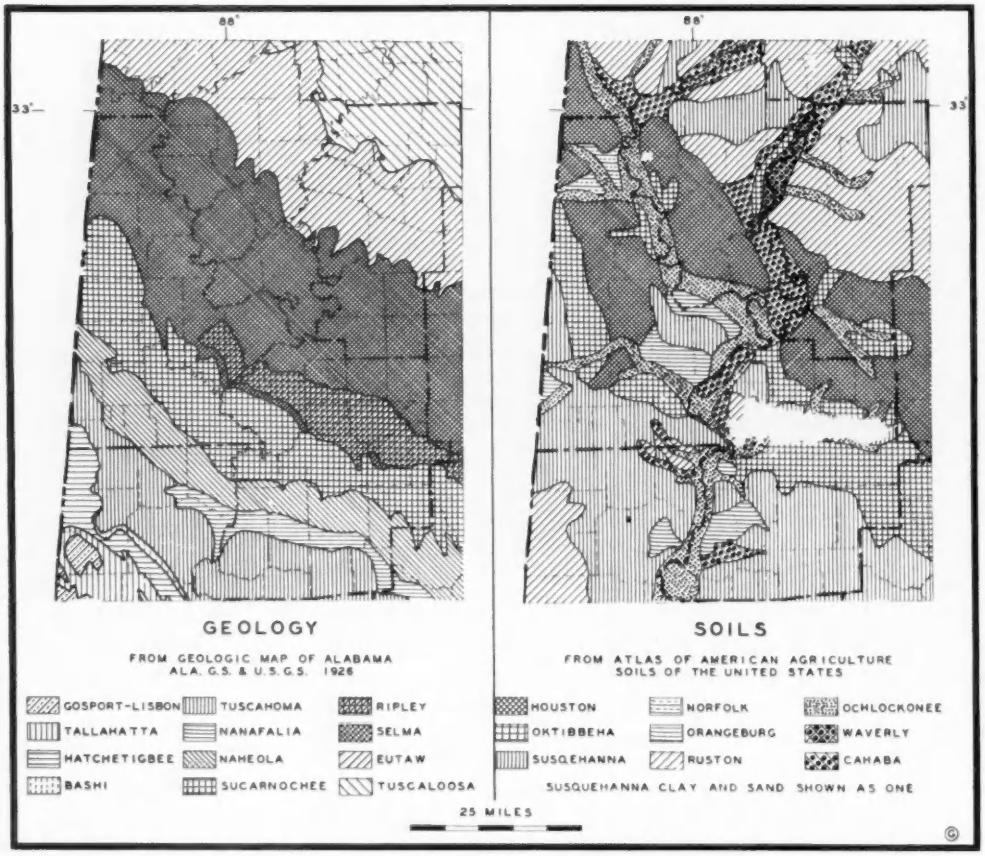

FIGURE 3.—Generalized geology and soil maps of a Black Belt cross-section in western Alabama embracing Greene, Hale, Marengo, and Sumter counties. Note the widespread distribution of flood plain soils (Ochlockonee and Waverly) and terrace soils (Cahaba) overlying the Selma chalk. Houston soil (much of which is now classed as Sumter, a degraded Houston) thus occupies only about half the area of Selma chalk with which it is associated.

CLIMATE

The climate of the Black Belt differs but little from that of adjacent areas. It combines all the features, good and bad, of the humid mesothermal type, with the interior phase rather than the coastal phase dominating.

Abundant rainfall averaging about 50 inches annually, with decided minimum in autumn (in contrast to a rainy autumn on the Gulf Coast), provides not only ample moisture for growth but also an essential dry picking season for cotton.

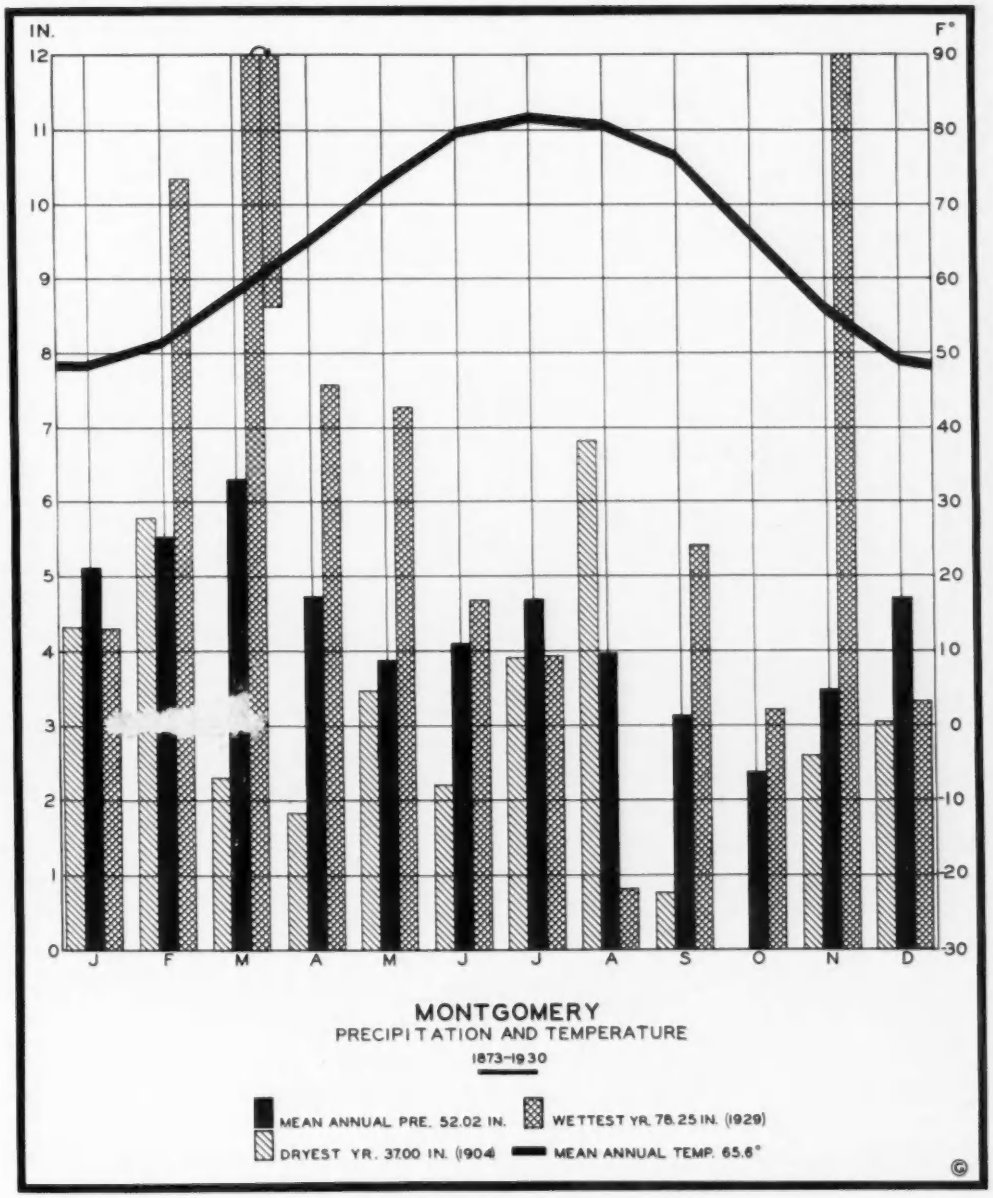

FIGURE 4.—Wide variations in annual and seasonal precipitation fail to produce hazardous extremes of climate in the Black Belt. Two years out of three deviate only slightly from normal precipitation conditions. (Data from U. S. Weather Bureau reports, Bulletin W.)

Precipitation.—Precipitation, practically all of which falls as rain, varies considerably above and below the annual mean, the deviation at Montgomery during the 58-year period ending with 1930 being from 37 inches (1904) to 78.25 inches (1929) (Figure 4). Such a wide variation in annual rainfall, however, is not highly significant since the type of agriculture practiced in the region is adaptable to annual rainfall averaging upwards from 35 or 40 inches. Eight years during the above mentioned period brought rainfall in excess of 60 inches and eleven years supplied less than 45 inches, leaving 39 years (roughly two-thirds) deviating only slightly from the normal.

Seasonal variations in rainfall, on the other hand, become somewhat more important, sometimes resulting in greatly reduced crop yields and devastating floods (Figure 5). Occasional summer droughts cause low crop yields, but complete crop failure from drought is very rare. One summer in eight or ten has three to five months with rainfall about half the normal (examples 1914, 1917, 1930). But most drought years have considerable rainfall deficiency in autumn, normally the dry season; this condition reduces the seriousness of such droughts.

More serious than droughts are prolonged periods of rainy weather in summer. Normally about one-third of the summer days are rainy, most of the rain coming as thundershowers of short duration. At times, however, cool drizzly rain and cloudy weather continue for days. The summer of 1939 had considerable rainy weather, 30 inches of rain and 66 rainy days being recorded between May 7 and August 27 at Livingston. Temperatures, however, remained somewhat above normal. Unusually cool, drizzly weather continued through early summer of 1940. Between June 6 and July 20, 33 days were rainy and nearly 21 inches of precipitation fell. (This is the rainiest July, and the second rainiest month on record.) Temperatures for May, June, and early July averaged about three degrees below normal. Such weather promotes weed growth, retards cultivation, greatly injures grain and hay, hinders the proper development of the cotton plant, and greatly stimulates the boll weevil.

Temperatures and Seasonal Characteristics.—The seasonal march of temperatures bespeaks the continental character of the climate. January and July are the coldest and hottest months, respectively. Winters on the whole are mild and short. The minimum temperatures of the Black Belt during the average winter weather as a rule are somewhat lower than those of adjacent areas. This condition doubtless is associated with the topographic-depression character of the region which tends to trap the cold air in the lowland. Frosts threaten during a period of about four months from mid-November onward, with many frostless nights and warm days interspersed between frosts. Montgomery has an average of 20 days with minimum temperature 32 degrees or below. About one year in two has minimum temperatures below 20 degrees and sub-zero temperatures are not unknown. The absolute minima for the region were set in 1899 when readings as low as minus seven degrees were observed. But January, 1940, set a new record for continued cold. Temperatures of minus five degrees or lower were observed. The temperature for the month at Livingston averaged 32.8 degrees, 12.8 degrees below the January mean, and on 17 days during the month temperatures dropped to 20 degrees or below.

Summers are not unusually hot for the latitude; but the heavy rainfall of that season maintains high relative humidity, which intensifies the heat and raises the sensable temperature somewhat above actual dry-bulb readings. Temperatures are never extremely high. Readings ranging from 104 degrees to 109 degrees have been observed throughout the region; but such temperatures do not frequently occur. One year with another, the highest temperature is about 99 degrees, and only one year in three or four has temperatures exceeding 100 degrees; that rarely occurs more than two or three days in a given season. But the July mean of 81 degrees, only 18 degrees below the highest temperature of the average year, suggests continuity of moderately high temperatures rather than subjection to hot waves, a condition characteristic of the Middle West and the Southwest. With the cessation of rains and the clearing of skies in September, higher sunshine ratio largely offsets shortening of days and declining of light rays. Thus, summer drags on another month or more, with little relief from heat but with considerable melioration resulting from the lowering of humidity.

Autumn contrasts with summer, largely because of a marked reduction in rainfall and a consequent lowering of humidity, rather than as the result of relief from heat. The first killing frost usually occurs between November 1 and November 15, and "Indian Summer" weather as a rule continues well into November, interrupted by passing cyclonic storms and occasional hurricane disturbances which sometimes reach inland to the Black Belt.

Spring is the shortest season of the year. Warm days in late February and March sometimes start vegetation to budding, only to be killed by an unseasonable frost; whereas, at other times continued cold of winter forestalls early budding. The rainy season is at its height in spring, usually in March; and by the time flood waters subside (at least by middle or late May) the hot weather of summer as a rule is under way.

FIGURE 5.—The highway rôle of rivers, although still of some importance, has declined greatly in the Black Belt in recent decades. Tombigbee River in flood stage, July, 1940.

The long growing season—250 days at Montgomery—usually begins about the middle of March, and allows roughly a six-months' season of abundant rainfall before the dry harvest period starts in September. Thus, temperatures, rainfall, and length of growing season suffice for practically all southern crops except sugar cane and citrus which are confined to the coast.

Climate as a Resource.—Climate has done much to shape human culture in this region. In an indirect, passive way its mild and pleasant attributes

entice man to a life of ease in the out-of-doors. He escapes the impelling drive of cold and drought; and the monotony of long, hot summers dulls his desire for activity and change. Many praise the region's climate and reject verbally its enervating effect, yet they adopt readily the hot weather excuse to explain their disinclination toward heavy work and their dependence upon non-dependable negro labor.

Climate, perhaps, is the region's greatest natural resource. Its abundant rainfall and mild temperatures favor a wide variety of agricultural crops and a luxuriant growth of pasture grass. Food crops can be harvested throughout most of the year and winter stall-feeding is unnecessary except in extreme weather. To many of the region's populace the degree tc which climate simplifies the problem of providing the necessities of life holds special appeal. For, in few other parts of this country does climate so much encourage pursuit of the path of least resistance, a course to which many adhere. Climate sets the price of human existence considerably below the requirements of regions with rigorous climate and resulting high costs of shelter, fuel, and clothing.

FIGURE 6.—Memorial Bridge on U.S.Highway 80 across Tombigbee River (Figure 5); known locally as "Rooster Bridge," because it was financed in part by an auction sale of roosters. (Note drawbridge feature.)

SURFACE AND DRAINAGE

On the whole the Black Belt has a gently undulating surface, the swale and swell topography of black soil overlying the Selma chalk being the general rule. Relief throughout the region is small, amounting to less than 100 feet over large areas; the general elevation above sea level approximates 150 to 200 feet. Uniform weakness of the underlying chalk has hastened the processes of normal erosion in the interstream areas as well as near the stream courses. Except where isolated upland patches of sand, and areas of clay and sand mixtures, called post oak land, cover the chalk, removal has proceeded about as rapidly as weathering; in many places only a thin mantel of soil or disintegrated rock remains resting on the chalk.

Stream courses are well defined; in most places, however, they are not cut deeply below the general level. As the major streams meander through their broad valleys in many places they cut against their outside banks where cliffs rise as chalk bluffs ten to fifty feet above low-water level (Figure 7). Such bluffs form only one bank at a given place. With the river flowing at their immediate foot they face low-lying bottom lands stretching in places for several miles back from the opposite side of the stream. Numerous sloughs hold stagnant water from one flood to the next, whereas a few abandoned channel lakes stand at elevations somewhat above all but the uppermost of recent high-water marks.

Obviously, poor drainage conditions prevail in most bottom lands. Slope is too slight to permit satisfactory surface run-off during periods of excessive

rain, and following river floods. Most streams have not cut their channels deeply enough below the general level of the bottom lands to keep the water table at a depth necessary for satisfactory underground drainage except during late summer and fall when river, ground water, and rainfall cycles reach their minima. Thus, considerable areas of water-logged, mosquito-infested bottom lands bearing covers of coarse marsh grass or mixed hardwoods contribute little to the economy of the region. Better drained alluvial bottoms, on the other hand, subjected less frequently to flooding, when cleared of their usual cover of mixed hardwood comprise the choice soils of the region. They yield excellent crops of corn except when spring floods come too late or continue too long, although as a rule all except the best drained of such soils prove too moist for cotton. Bottom lands cannot always be counted upon for cotton or corn, because frequently flood waters do not recede early enough to allow time for the normal crop cycle, and large acreages thus remain out of crop production.

The formation bordering the region on its seaward side offers more resistance to channel cutting than does the Selma chalk. This condition has retarded valley deepening within the chalk belt; therefore, stream gradients remain low. Along the master streams—Alabama, Tombigbee, and Black Warrior—meandering courses and abandoned channel lakes suggest at least a temporary base-level stage.

Major streams carry considerable sediment from rapidly eroding areas outside the region, and local tributaries add their loads of Black Belt soil. Streams appear muddy even in time of low water, and both immediate channels and overflow lands are subject to considerable siltation.

FIGURE 7.—Selma chalk bluffs along the Tombigbee River at Epes, Sumter County. Note the river level within a few feet of flood stage.

The larger rivers maintain channels sufficiently deep to accommodate barges and small river boats. Navigation on the Black Warrior extends to Birmingport, the river port of Birmingham, about 100 miles (by river) inland from the chalk belt, and on the Alabama to Wetumpka, 25 miles north of Montgomery. Increased gradient in the hill country north of the chalk belt necessitates several sets of locks. Locks are necessary down stream from the chalk also, on both the Tombigbee and the Alabama; but within the chalk areas locks are less necessary. The bulk of the river traffic moves down stream chiefly by barge. Coal is the largest single commodity; it moves in large quantities from the Birmingham mining district to Mobile for use in that city, for fueling ocean vessels, and to some extent, for export. Considerable quantities of steel from the Birmingham area move by river barge. Pine logs cut largely from regions bordering the Black Belt move chiefly by raft to the Mobile area. Sand and gravel dredged from stream beds which move by barge for use locally in construction work, add considerably to river tonnage. Only limited river shipments move upstream; the majority consist of light mixed return cargoes and short hauls.

SOIL AND VEGETATION—RELATED ANOMALIES

When De Soto crossed Alabama in 1540 he took advantage of sparse tree growth, grass vegetation, and level terrain of the Black Belt in directing his course westward through the state. Accustomed to traveling through forests of pine and mixed hardwoods in the earlier part of his march, he welcomed the open nature of this region. Early settlers who came to Alabama more than two centuries later marveled at the extensive stretch of rolling timber-studded grassland, surrounded by forests. Like early settlers of other prairie regions they failed to consider the all-important soil factor as an explanation of the strange vegetation anomaly. Today, to the geographer who views with interest and concern the dark soil and the prairie vegetation of the region, the individual, separate occurrence of either phenomenon would seem strikingly irregular, yet their combination appears logical.

Records available give no definite information regarding the extent to which the Black Belt bore timber when the first settlers came, although some believe that considerably less than one-half the area was actually treeless. Mohr, who studied the region in the 1890's writes, "The term 'prairie region' refers less to the timberless tracts, which originally formed a small fraction of its area, than to the black, calcareous, highly fertile soil of these uplands, which being rich in humus as a result of the reaction of its calcareous constituents upon vegetable matter, closely resembles the equally productive soil of the western treeless prairies." Since most of the land has been in farms for over a hundred years, it is impossible to distinguish cleared timber land from land originally set in native grass.

The Selma chalk that underlies the Black Belt weathers readily into a bluish-gray, highly calcareous clay, especially adapted to the growth of tall prairie grass. Abundant grass root growth in particular, and large annual fall of stems and blades, to a less extent, on decaying add much humus to the calcareous, fertile clay. Thus, these soils have acquired a dark color which has become almost black in places of slight relief where erosion and exhaustion have not disturbed them. In a region where soils are dominantly light in color—for the most part red and yellow—these rich, dark soils become very striking in appearance. Also, the fact that one observes more frequently and more carefully grass-covered soils than soils obscured by timber, adds to the conspicuous nature of these dark soils which have given the Black Belt its name. Thus, much misinformation has resulted regarding the extent of these soils. Popular reference to black soil leaves the impression that it is by far the most extensive soil of the region; but on the basis of total area its extent is quite small, probably amounting to less than one-fourth.

Other soils of the Black Belt vary widely in color, texture, chemical composition, and agricultural quality. These soils fall roughly into two groups: (1) river alluvium, both of recent and old deposition, and (2) upland soils derived from drift and other materials resting on the chalk. Most of these soils originally bore timber, largely hardwoods; but pines, which comprise roughly one-fifth of the total timber cover, appear in sizable tracts in places on the uplands. The river alluvium comprises the best soils of the region and some of the upland soils prove excellent for farming.

Four counties—Greene, Hale, Marengo, and Sumter—astride the Black

Belt in western Alabama provide a typical and convenient cross-section with transitional margins, north and south. A close-up view of this cross-section (Figure 3) reveals interesting relationships between geology and soils, most striking of which is the way the Selma chalk limits very sharply the group of calcareous soils. These maps are somewhat generalized, particularly the soil map. It fails to show much of the details observable in the field and shown by recent unpublished United States Soil Survey county maps. The geology map also is lacking in detail.

FIGURE 8.—Accelerated erosion removes the soil material as rapidly as it forms; under abuse and neglect much of the surface remains stripped to the raw marl. (Selma chalk upland three miles southeast of Epes, Sumter County.)

The Houston soil, the *rendzina* characteristic of formations similar to the Selma chalk, does not reach full development in this region. Accelerated erosion removes the soil material as rapidly as it forms; under abuse and neglect much of the surface remains stripped to the raw marl (Figure 8). Thus, the true Houston profile exists here in very few instances. Most soils mapped as Houston are only Houston-like. The best preserved soils retain the characteristic black color; but the majority are brown to ash-gray, showing humus deficiency and strong color traces of raw marl.

In Sumter County (bordering Mississippi) less than one per cent of the total area (roughly five per cent of the Selma chalk) now is mapped as Houston. A large proportion of the soil mapped as Houston about 40 years ago now is classed as Sumter, a degraded Houston. Sumter County is somewhat more hilly than some other Black Belt counties and doubtless has suffered more from erosion. But throughout the region soil degradation has progressed rapidly during the last half-century.

In the process of normal stream erosion which reduced the Black Belt to a lowland plain, low-gradient rivers winding through broad, flat valleys have performed the double work of eroding from the higher levels and depositing sediment in the lowlands. Heavily charged with sediment gathered in part from the regions to the north and in part from the local region, these streams have spread thick mantels of rich alluvium throughout their valleys. Gradual lowering of stream beds has left many stretches of old alluvium standing as terraces above the reach of present flood waters. A surprisingly large proportion of the Selma chalk lies buried beneath these deposits. The rather extensive flood plain and terrace soils (shown in stippled patterns in Figure 3) attain their greatest extent about the junction of the Tombigbee and the Black Warrior rivers, but they are quite prominent along these major

streams and along most of their tributaries. The Ochlockonee, the characteristic flood plain soil, occupies areas subject to flooding at present; its association with the present drainage system accounts largely for its drindritic pattern. It has a brownish color, is only moderately well drained, and is relatively easily cultivated. Frequent flooding renews its fertility, and the better drained areas are among the best soils of the region. These soils are especially well adapted to corn, but as a rule they are too moist for cotton.

The Cahaba series occupies most of the terraces. These well drained reddish loam and clay-loam soils are adapted to a greater variety of crops than are the flood plain soils, although on the whole they are less fertile since they are not subject to renewal by flooding.

Overlying the Selma chalk along its southern margin, sands and clays belonging to the Succarnochee and Ripley formations give rise to Oktibbeha and associated soils. These red clay and clay-loam soils have relatively close contact with the Selma chalk and are classed as degraded *rendzinas*. Normally they have better developed profiles than the Houston, are only slightly calcareous, and since they have developed under a cover of pine and mixed hardwoods, have a relatively low humus content. These soils are well adapted to timber and some of them produce pine and hardwoods on a commercial scale. Some Oktibbeha soils, however, yield fairly good returns under the practice of general farming.

In many parts of the Black Belt drift materials mantel the Selma chalk forming ridges and low hills. Soils of these uplands vary considerably in texture and agricultural quality. Some resemble the Oktibbeha soils described above. Others that have developed on a deep mantel of clayey drift bear stands of oak and are known locally as "Post Oak" soils. Still others are decidedly sandy, bear pine and mixed hardwoods, and are fair for general farming use.

For the most part soils of the western Black Belt are only fair for crops. A recent land classification map of Alabama, prepared by the Resettlement Administration, rates none of the land of this area among the best of the state, and relatively little receives second rating in the six-quality classification.

Furthermore, contrary to general opinion, the black prairie soil developed on the Selma chalk is not the best soil of the region. Due in part to depletion, in part to seasonal retardation of crop growth, and in part to the high degree to which these black limy soils become infested with Johnson grass and weeds, cotton yields much less and requires much more cultivation than on some upland and terrace soils. Agriculturists recommend oats, hay, and pasture rather than cotton and corn for the dark limy soils.

For the region as a whole, emphasis falls on cotton, the only cash crop and the crop leading in acreage and importance. Corn, however, runs a close second, passing cotton in acreage in some counties. It supplies much of the feed and a large portion of bread grain consumed locally. Oats are becoming more important in some sections, and with increased emphasis on beef cattle, hay and pasture grasses receive increasing attention. All crops yield only fair returns under good management; whereas, under average tillage in the hands of negro tenants (Figure 17), yields might be considered meager.

POPULATION

The Black Belt is strikingly rural. Only two towns within the region

proper, Selma (Population 1940, 19,874) and Demopolis (4,184), reach the Census Bureau's 2,500 minimum for urban classification. Montgomery (78,008) might be considered a Black Belt city, although it stands just outside the Selma chalk.

Figure 9 shows distribution and composition of population in the western Black Belt, a cross-section that epitomizes the region as a whole. This figure emphasizes the rural and small town character of the population patterns. The non-farm element occupying small towns and villages, comprises about one-sixth of the total population. Farm population makes up practically all the rural element. Most of the individual farm units are in the hands of negro tenants; on the whole they are small, averaging about 50 acres each. Farm families crowd the areas of better soil, especially the level, highly arable tracts (Figure 10). In areas of poorer soil, particularly in the margins of the region, population scatters somewhat more widely. But, in spite of variations in arability and agricultural affluence, rural population adheres to a rather even pattern.

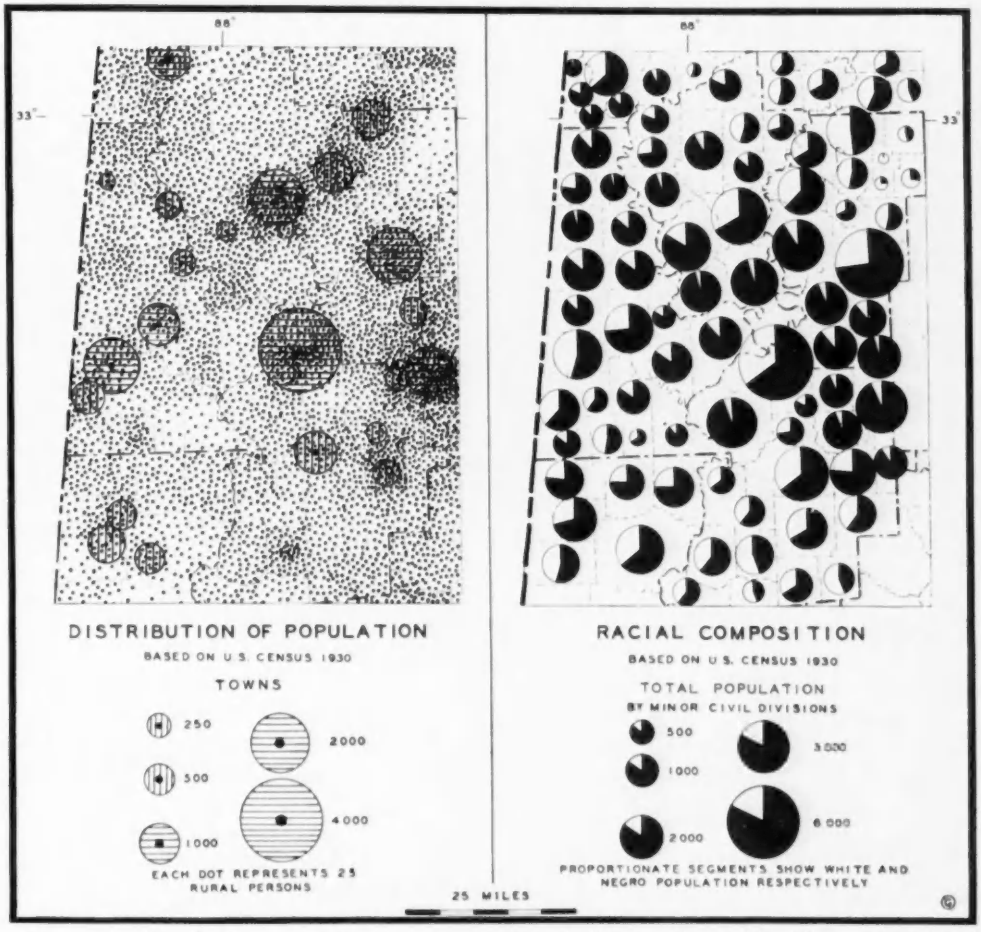

FIGURE 9.—Population maps of the same area shown in Figures 3 and 10. The western Black Belt is strikingly rural with a relatively even distribution of population. Alignment of small towns conforms to the rail pattern. Negroes outnumber whites four to one in the heart of the region, comprising more than 95 per cent of the total population in some districts.

Several old towns antedate the railroads and doubtless influenced rail courses; younger towns have grown up along the rail routes. Thus, the urban alignment conforms closely to the rail pattern. No one town of the section enjoys special locational advantages over others. As a product of its respective community, each town serves as a local trade center. County seat rôles provide official and technical positions of responsibility which enhance the importance of such towns. Old river towns at present realize little from their locations which proved advantageous in earlier days. Gainsville, on the Tombigbee, with a population of 284 and with neither railroad nor paved highway remembers remorsefully the glory of a century ago, when its rich hinterland and promising river trade challenged the deliberation of such enterprising corporations as Swift's Packing Company, which reluctantly eliminated Gainsville in favor of Chicago, in locating its headquarters plant.

TABLE I

POPULATION NUMBERS: 1880–1940

Four Western Black Belt Counties

	Greene	*Hale*	*Marengo*	*Sumter*	*Total*
Total: White and Negro					
1880	21,931	26,553	30,890	28,728	108,102
1890	22,007	27,501	33,095	29,574	112,177
1900	24,182	31,011	38,315	32,710	126,218
1910	22,717	27,883	39,923	28,699	119,222
1920	18,133	24,289	36,065	25,569	104,056
1930	19,745	26,265	36,426	26,929	109,365
1940	19,269	25,690	35,980	27,289	108,138
White					
1880	3,765	4,903	7,276	6,451	22,395
1890	3,236	5,180	7,946	5,943	22,305
1900	3,307	5,664	8,842	5,672	23,385
1910	3,012	5,896	9,077	5,377	23,362
1920	3,090	6,393	9,954	5,738	25,175
1930	3,482	6,853	10,077	5,682	26,094
1940			Data not available		
Negro					
1880	18,166	21,650	23,617	22,277	85,710
1890	18,771	22,321	25,149	23,631	89,872
1900	20,875	25,347	29,473	27,038	102,733
1910	19,705	21,987	30,846	23,322	95,860
1920	15,043	17,896	26,111	19,831	78,881
1930	16,263	19,412	26,349	21,247	83,271
1940			Data not available		

TABLE II

POPULATION COMPOSITION: 1880–1930

Four Western Black Belt Counties

	Greene	*Hale*	*Marengo*	*Sumter*	*Total*
Per cent Negro					
1880	82.7	81.6	76.5	77.6	79.2
1890	89.3	81.2	76.0	80.0	79.9
1900	86.6	81.5	77.0	82.7	81.2
1910	86.8	78.8	77.3	81.2	80.3
1920	83.0	73.7	72.4	77.6	75.6
1930	82.4	73.9	72.3	78.9	76.1
1940			Data not available		

TABLE III

INCREASE AND DECREASE IN POPULATION: 1880–1940

Four Western Black Belt Counties

	Greene	*Hale*	*Marengo*	*Sumter*	*Total*
Total Population					
Percentage change for decade ending					
1890	+ 0.5	+ 3.5	+ 7.0	+ 2.6	+ 3.8
1900	+ 9.8	+12.8	+15.8	+10.4	+12.5
1910	− 7.0	−10.2	+ 4.0	−12.3	− 4.7
1920	−20.3	−12.8	− 9.7	−12.5	−12.7
1930	+ 9.0	+ 8.2	+ 1.1	+ 5.2	+ 5.1
1940	− 2.4	− 2.5	− 1.2	+ 1.4	− 1.1
White Population					
Percentage change for decade ending					
1890	−14.0	+ 5.6	+ 9.2	− 7.9	− 0.4
1900	+ 2.2	+ 9.3	+11.3	− 4.6	+ 4.8
1910	− 8.9	+ 4.1	+ 2.7	− 5.2	− 0.1
1920	+ 2.6	+ 8.4	+ 9.7	+ 6.7	+ 7.8
1930	+12.7	+ 7.2	+ 1.2	− 1.0	+ 3.6
1940			Data not available		
Negro Population					
Percentage change for decade ending					
1890	+ 3.3	+ 3.1	+ 6.5	+ 6.1	+ 4.9
1900	+11.2	+13.6	+17.2	+14.4	+14.3
1910	− 5.6	−13.3	+ 4.7	−13.7	− 6.7
1920	−23.7	−18.6	−15.3	−15.0	−17.7
1930	+ 8.1	+ 8.5	+ 0.9	+ 7.1	+ 5.6
1940			Data not available		

Negroes outnumber whites four to one in the heart of the western Black Belt. In some strictly rural districts they comprise more than 95 per cent of the total population (Figure 9). In the transitional margins, however, negroes become less numerous, actually and relatively, the two races approximating a numerical balance in the far outer borders. White proportions ranging from one-fourth to one-half in urban centers, reflect the absentee landlord rôle of white farm owners, and the tendency of white people toward business and professional pursuits. (Witness the urbanized districts: Demopolis 34 per cent white; Eutaw 33 per cent; York 45 per cent; Livingston 26 per cent. Corresponding figures for the larger cities, Montgomery and Selma, are 55 per cent and 49 per cent, respectively.)

Population Trends.—The accompanying tables and graph show changes in number and racial composition of population in four western Alabama counties during the sixty years ending with 1940. Owing to the fact that the South did not become well adjusted to its post-slavery epoch until some years after the close of the War between the States it seems appropriate to exclude from this study census data enumerated earlier than 1880.

Until 1900 population gained slowly, the peak being reached about that date (Figure 11). But the gain was far below the natural increase (excess of births over deaths). For a long time the Southeast, with high birth rate and large families, has contributed freely to other parts of the United States its human resource of surplus population. The natural increase for the Black Belt, however, has been somewhat lower

than for the Southeast in general. Many migrated from the Black Belt, the majority of the migrants being whites. Immediately after the War between the States the major movement was westward, largely to Texas and California. During the 1880's, 1890's, and the early part of the present century, however, many who left the farms and the small towns of the Black Belt went to cities of Alabama. Birmingham drew more than all other cities of the state combined, whereas Mobile, Montgomery, Tuscaloosa, and small towns and rural areas outside the Black Belt attracted many.

The high per capita wealth which the white populace acquired during plantation days contributed to a remarkably high level of rural culture. Many young people studied in the better schools of the United States and in foreign countries. Most young men trained for professions, law and medicine attracting a large number. Considering its sparse white population, the region has produced a remarkably large number of professional and civic leaders. Even today with most family fortunes greatly depleted, the more promising youth attend college and prepare for leadership rôles. Obviously, the Black Belt has never offered many opportunities for people with professional training and ambition; hence, the bulk of the more promising ones have sought opportunities in the cities of Alabama and of the North and East.

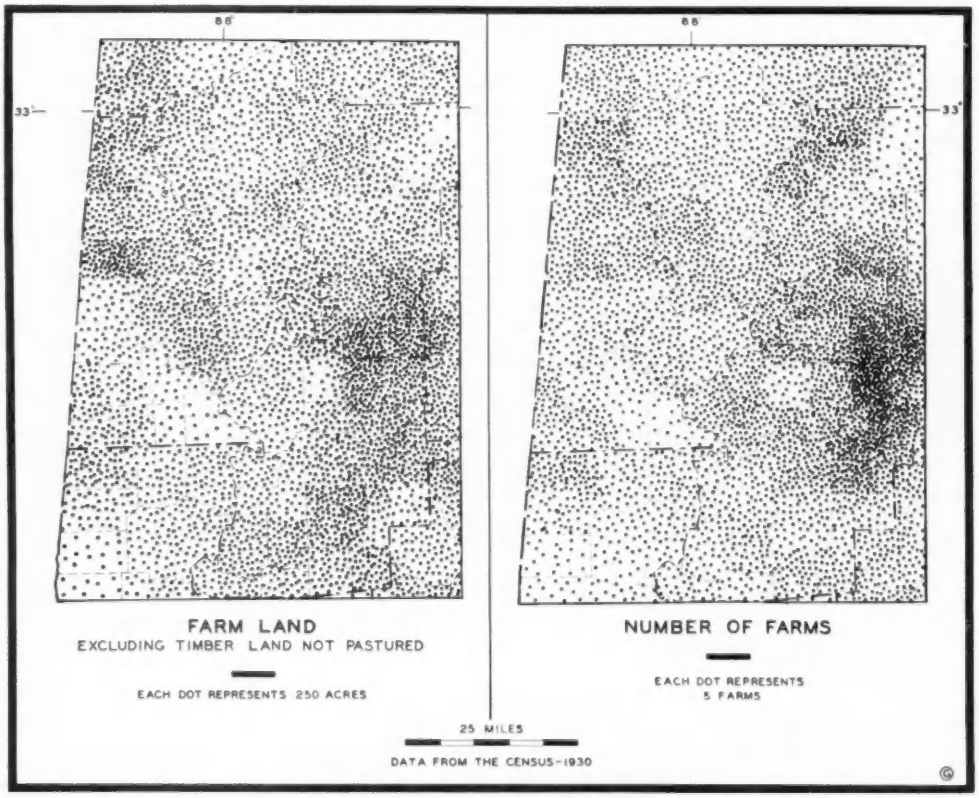

FIGURE 10.—The area shown here is the same as that in Figures 3 and 9. Farms of this section average approximately 50 acres in size. The greater concentration of both farm acreage and number of farms in the eastern part marks one of the best farming sections where relatively little land is not in farm use.

Negro population gained much faster than white population during the period of 1880 to 1900, the increases for the two races being 20 per cent and 4.4 per cent, respectively. Birth rates did not differ greatly for the two groups, and the greater gain of negro population reflects a much smaller percentage of migration to other regions. The generation of negroes freed from slavery as a result of the War were reluctant to risk their chances in new and distant surroundings; they preferred instead the security and satisfaction of their former homes.

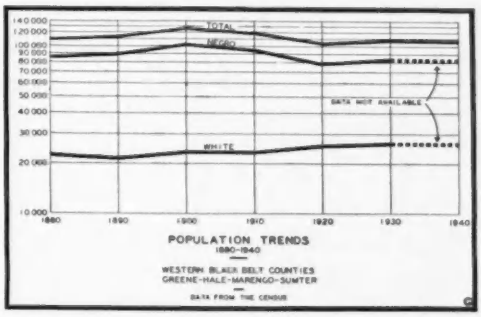

FIGURE 11.—The decline in total population and in negro population, and the increase in white population in the Black Belt since 1900 suggest an interesting study in regional demography.

The first twenty years of the present century saw a reversal of population trends in the Black Belt—a net loss of total population rather than a gain. During the first decade the natural increase of white people approximately balanced with migration, but the next decade brought a substantial growth. Negroes on the other hand, migrated in large numbers, the loss during the twenty years amounting to nearly one-fourth of the total. This reversal of trends finds its explanation in two factors. The first is the human factor. A new generation of negroes had grown up in the Black Belt—a generation that had forgotten many of the ties that held their fathers to the old plantation home—a generation a bit more enlightened, a bit more inquisitive and, perhaps, a bit more ambitious to seek their fortunes in new environments than their fathers had been. The second factor is economic in nature. The industrial development particularly in Birmingham and to a less degree in the North and Middle West provided thousands of jobs for unskilled workmen, and many of the more industrious and ambitious negroes left the Black Belt and other parts of the South in response to this newly-opened opportunity for employment. The coming of the boll weevil about the close of the second decade brought untold trouble to the cotton farmer. The new pest took one crop after another, leaving stranded the negro farmer who knew no other type of farming than cotton growing. Many left the farm discouraged, and turned northward to join countless others who proceeded them to factory jobs and high wages in Birmingham, Chicago, Detroit, and other industrial cities.

Migration from the Black Belt continued during the early 1920's; later in the decade, however, both races resumed growth. During this period migration northward continued, but at an arrested rate. A reduced drain on the land resulting from the release of population pressure through migration improved conditions somewhat, and better prices for farm products held many to the land.

The decade ending with 1940 saw a very slight decrease in population in this region—a much smaller change than in many other parts of the South. The backing up of youth on the farm, characteristic of the nation as a whole in the early 1930's did not result in a great increase in farm population here; on the other hand, several Black Belt counties experienced a decrease in num-

ber of farms in 1935. In consideration of the many problems wrought by the depression, the population of the Black Belt has remained relatively stable in numbers, although many acute problems of unemployment remain unsolved.

Population shifts during the last sixty years have been of relatively minor consequence. The changes have been too slight numerically to alter greatly the ratio of population to arable acreage. But, in consideration of the great decrease in productive capacity of farm land and significant decline of the cotton crop, especially since the advent of the boll weevil, even a slight change in number and racial compositions become significant. The rising costs of living (in goods if not in cash) doubtless has been greater for the white people than for the negroes. The pronounced increase in ratio of white people to negroes represents a corresponding drain on the land of the region.

Another consequence of the population shifts, minor though it may be, is a lowering of the quality of the negro element. Negro migration during the period of high wages and abundant employment included the more ambitious, more progressive element, leaving behind a less capable group. The result has been a present generation of negro farmers and servants in general inferior to the last generation.

FARM LANDSCAPES

Farming is the Black Belt's main business of life. From the earliest date of settlement to the present, no other industry has functioned in the region except on a very small scale. About 75 per cent of the population live the lives of farmers and most of the remainder depend directly or indirectly upon farming.

FIGURE 12.—The two houses pictured here are above average farm owner homes in architecture and state of repair.

A. This house was built as a plantation home about 1843. It is now occupied by the owner of the plantation on which it stands, who is one of the most successful cattlemen in the Black Belt. The type of architecture represented here, although seen frequently throughout the Black Belt, is not so typical of the region as is the type represented by the houses shown in Figure 2. Serving as "The Big House," this residence has remained in constant use and good repair. Additions to the original structure have altered somewhat the original plan.

B. A comfortable bungalow representing the modern element in farm home architecture in the heart of the Black Belt.

Many farm holdings of the region are small; yet the small one-family farms comprise a relatively low percentage of the total farm acreage. About four out of five farmers are tenants, most of whom tend small subdivisions of large farms. About one-half of the farmers of the region operate tracts ranging in size from 25 to 50 acres.

Many of the large land holdings which characterized the region two generations ago have been subdivided, although, the large estate system still

prevails in a degree too great for the economic good of the region. Estates of several hundred acres to four or five thousand acres each, operated by a dozen to 50 negro tenant and share cropper families, in a large measure have preserved the bearing of the plantation of earlier days. Some estate owners live on their estates; others make their homes in villages and towns and pursue their managerial duties. Others retire completely, placing the estate in the hands of a hired manager, or renting it to an operator.

On these estates the operator, whether owner, manager, or renter, occupies relatively good quarters; many have comfortable houses with running water, electricity, and other modern conveniences (Figure 12). Most of the negro tenants, however, occupy miserable shacks of one, two, or three rooms (Figures 13 and 14); these are uncomfortable both in winter and in summer. In most instances tenant houses are widely dispersed over the farm; as a general rule each house stands alone, with few if any auxiliary out-buildings. Such a dispersed pattern of tenant buildings contrasts strikingly with the concentrated negro quarters characteristic of the early plantation.

Barns and out-houses on the whole are small and cheaply built. The mild climate permits year-round grazing; hence, most farmers do not practice housing and stall-feeding of livestock to any appreciable extent. Most farmers store their corn in barns or cribs for winter feeding and for family bread. Relatively little hay finds shelter; the bulk goes into circular stacks in the open, a practice of questionable economy in a region of 50 inches annual rainfall. Machine equipment of the average negro farmer is meager and tool-sheds are lacking on most farmsteads.

A rectangular pattern of small fields prevails in areas of very slight relief. In most places, however, fields assume an irregular pattern since moderate slope and heavy rainfall necessitate contour plowing or terracing. The more progressive farmers of the region have practiced terracing for many years. But on many farms terraces have fallen into bad repair through poor management in the hands of negro tenants who know little of keeping them repaired. The present work of soil conservation is accomplishing a great deal of good through a large scale terracing program which the farm owners and the government finance jointly (Figure 15). Time alone can tell whether the negro farmers of the region will care for the new terraces in a way that will justify the great outlay on the present program.

FIGURE 13.—Characteristic Black Belt negro tenant houses.

A. Somewhat above the average, with good metal roof, reasonably tight walls, and brick flue.

B. One of the very old log cabins that fire has not claimed. Although this is one of the poorest now in use, many negro families occupy houses little more pretentious than this. (Note "dog trot.")

FIGURE 14.—The Black Belt negroes are a light-hearted happy folk, finding contentment in their lot, whatever it may be. They enjoy very much being photographed. This is one of the poorer type residences.

Numerous small clearings and eroded, abandoned fields add to the patchy nature of the farm pattern. Pasture land includes most non-cropped acreage with the exception of some timbered tracts; exclusive of abandoned fields the bulk of the pasture land is too rough or the soil too thin for crops (Figure 8). Some farmers practice rotation which includes pasture in the programs. A considerable amount of pasture land is being terraced under the present program, and some is seeded in good pasture grasses. Improved pastures, however, are not the general rule.

TRENDS IN LAND ECONOMY

The Black Belt is no longer one of the South's important cotton regions, although cotton still leads all other crops in acreage and importance. The dark calcareous soils of Selma chalk origin and also the better-drained alluvial bottom lands formerly produced heavy yields, and the Black Belt ranked high as a cotton region. Boll weevil ravages in particular, and unstable markets and exodus of negro laborers to a less extent, have effected a great decline in cotton growing. Cotton acreage for the region as a whole dropped 50 to 60 per cent between 1910 and 1935; in areas of highly calcareous soils the decrease was even greater. Cotton gets a late start in the spring and grows slowly on these soils; hence, it suffers much more from the boll weevil attacks than does the earlier maturing cotton grown on well drained, upland soils.

With the decline of cotton, the mainspring of Black Belt agriculture, the

FIGURE 15.—A belated terracing program, active during the last few years, promises much toward checking soil erosion if negro tenants can and will keep the terraces in repair.

FIGURE 16.—Few regions in the South are as well endowed for grassland economy as is the Black Belt. Rich, calcareous soils and abundant precipitation yield excellent growths of native and introduced pasture grasses, on which cattle and sheep thrive.

A. Thoroughbred Herefords grazing on improved pasture. The herd of which this is a part is one of the finest in the Black Belt. It consists of about 350 brood cows (practically thoroughbred, but not registered) and fourteen registered bulls, yielding a fine calf crop annually.

B. Cattle of average quality grazing on Bermuda and other grasses. Many farmers and cattlemen build excellent herds by starting with ordinary cows and registered bulls.

region suffered a severe blow. The negro farmer of this section, by nature and experience, is a cotton grower. When the region made its first move toward diversification the negro knew little about growing other crops; and in more than twenty years of serious cotton troubles he has learned little that aids him in fitting into a diversified system of farming. Corn, a close second to cotton in total acreage, fits next best into the negro's habitual method of farming. Corn is reasonably well adapted to the region's climate, and the moist bottom soils produce good yields under proper tillage. Corn acreage has made substantial gains in recent decades; but unfortunately, production does not meet the demands of a rising cattle industry and the region imports feedstuffs yearly. Hay also has made recent gains and oats have met with some success in recent years. These crops are well adapted to the highly calcareous soils of the chalk belt.

Cattle Raising.—Cattle raising, a phase of agriculture for which Nature has richly endowed the Black Belt, is receiving considerable emphasis after a hundred years of soil exploitation through cotton culture. Genial climate and highly calcareous soils combine in producing excellent pasture grasses; and the wide range of soils, under proper management, will yield a varied and abundant supply of supplementary feed crops.

In an effort to overcome the loss suffered through the decline of cotton many farmers undertook cattle raising on a large scale in the period of high prices following the World War. Inexperience in handling cattle, together with the decline in prices in the early 1920's, brought serious trouble to the new industry. Many cattlemen lost heavily; by 1925 the total number of cattle dropped to somewhat more than one-half the 1920 figure. In subsequent years cattle raising increased gradually but steadily. By 1935 the number of cattle had passed the 1920 level, and the industry has experienced additional expansion since 1935.

The improvement in quality of cattle in the region is as significant as the increase in numbers. Many cattlemen have pure-bred herds (largely Herefords), and most others are making substantial improvements through careful selection of brood cows and introduction of pure-bred bulls (Figure 16). The Montgomery market to which the Black Belt is the greatest contributing

region, is one of the fastest growing cattle markets in the South. This market bases its business largely on the high quality beef cattle of the Black Belt.

Two factors threaten to curtail further expansion of the cattle industry: (1) limited feed supply, and (2) incompetent labor. The region is decidedly lacking in a feed supply necessary to finish for market all the cattle the pasture land will carry. Many cattle must be sold in unfinished form or fed high-priced, imported feed; either condition threatens the economic stability of the industry.

Lacking good judgment, a sense of thrift, and a feeling of responsibility, the average Black Belt negro is decidedly incompetent as a stock farmer. When left to himself he rarely attempts cattle raising on any appreciable scale; and when working for another he requires close supervision. The high ratio of negro to white farmers thus becomes a significant factor in limiting the expansion of the cattle industry.

Continued progress in the cattle industry, it seems, demands active participation of intelligent, energetic white farmers in the management and routine work of the cattle farm. And the hope is here expressed that this phase of grassland economy, for which the Black Belt is so well adapted, may not be neglected, but that it may receive the careful planning, the proper management, and the energetic pursuit so essential to its success.

THE WAY OF LIFE

Southern aristocracy, a vanishing cultural element, has lingered long in the Black Belt. Those who would see it survive reflect proudly on a bountiful heritage, accept passively the present, and view apprehensively the future. Reluctantly they accept the fact that exploitation of resources, dwindling of fortunes, and emigration of human talents have so weakened the foundation of this artistocracy as to threaten its long endurance.

FIGURE 17.—Crude methods by which negro tenants till the soil prove disappointing.

A new and different element has arisen. A substantial portion of the present generation accepts openmindedly the changes of a changing world, considers weakly-grounded aristocracy as superficial, and faces squarely the problems accruing from the belated departure from the older order. The change definitely has come. The traditional hold of plantation aristocracy is broken, and the transitional period is near its close. The progressive element of population rapidly is liberating society from the bonds of tradition and affiliating it with the America of today.

A definite bi-racial problem underlies the economic and social order of the

Black Belt. Nowhere in the South does a sharper color line exist; and nowhere do whites depend more upon blacks. The master–servant concept permeates the entire stratum of both races, and most white people hold an antipathy for farm labor that definitely opposes agricultural success in a region of inefficient negro labor. A minority group, however, holds no such horror for manual labor; nor does this group consider labor dishonorable. And the time has come when the exceptional farmer who takes pride in performing the major share of his work runs little risk of losing the esteem of his friends, thanks to a slowly changing popular attitude.

Servant and tenant rôles give the negro a degree of economic security, although his lot is a lowly one (Figure 14). Negro service, no cheaper in price than in quality, sets the pace of progress and determines the quality of work performed. Skilled white artisans, such as carpenters, brick masons, and plumbers, find competition with negroes unpopular and unprofitable. Under these circumstances standards of service must remain low.

FIGURE 18.—Relatively little hay finds shelter in many Black Belt communities. Much of it goes into stacks like these, a practice of questionable economy in a region of 50 inches annual precipitation.

Few regions in the South possessed such a rich endowment of soil as did the Black Belt. Few regions have allowed their resources to suffer such depletion. And perhaps, few regions face so difficult a problem of adjusting to the economic and social demands of a rapidly changing world. Evidently the time is past when the farms of this region will support adequately its population through backward, wasteful methods of negro farming (Figure 17). The drain is too heavy; the resources too depleted. Methods involving wisdom, experience, and energy of white farmers must prevail in a degree not yet demonstrated if farming, the region's one industry makes progress.

UNITED STATES FLAX INDUSTRY

George H. Primmer

FLAX shows again a remarkable production increase in the United States in recent years after reaching a forty-five year low point in 1937; whereas many crops show decline in land area demanded, in many sections of the United States, flax currently calls for more and more land. In Minnesota alone the estimated 1939 harvest, from more than sixty per cent national acreage, exceeded by some twenty per cent the flax area of the entire country in 1937 (Figure 1).

Why Grow Flax?

Flax producers for the most part currently receive a relatively high income. In a number of interested states records consistently show likelihood of higher net profit from flax than from either spring wheat or oats. Increase in this price spread has led many farmers to shift to flax or to increase their producing acreage. Furthermore, flax gives cash income, the general advantages of diversification, freedom from so great reliance upon imports to supply domestic needs, and an opportunity for the American farmer to grow a drying-oil crop under his mechanized agricultural system. For fifty years the United States imported great quantities of flaxseed and linseed oil, in recent years largely from Argentine. Much more expansion may follow with no imminent danger of national overproduction.

Relation to Other Crops

Flax yields, in some states, prove highest after soybeans or other legumes; in others, equal or higher yields follow corn, sugar beets, and potatoes. Where moisture does not serve as a limiting factor, mixed cropping, such as spring wheat and flax, gives maximum returns despite extra labor for separating seed. If commercial consumers take the flax straw, however, they desire it unmixed; flax straw income may thus more than nullify mixing gains.

Most commercial grain farmers find that they readily add flax to their cropping schedules since they already own all needed farm implements. By extending the season of use of equipment they materially reduce overhead

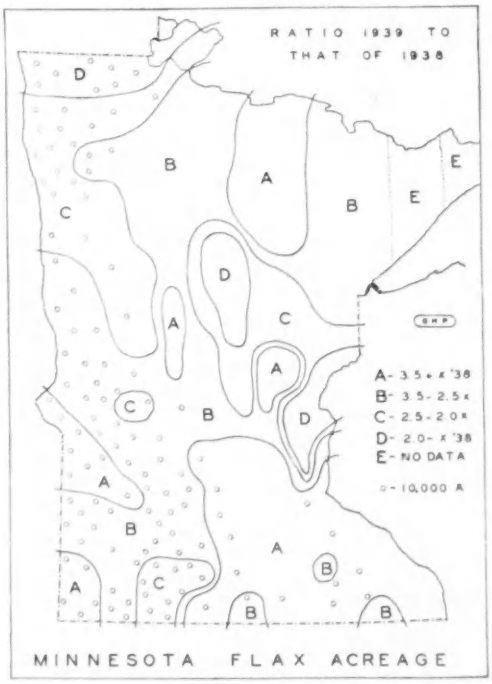

Figure 1.—In 1939 Minnesota put 1,232,000 acres into flax, slightly more than sixty per cent of estimated United States acreage, some 2,033,000 acres. Only four counties of record showed less flax area in 1939 than in 1938, and only the three small "D" areas failed to double the 1938 acreage.

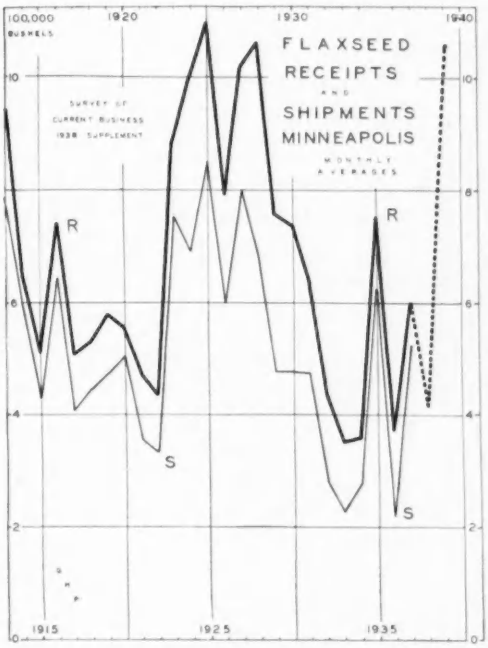

FIGURE 2.—The broken end, 1938–39, of the receipts line represents estimates of the Minneapolis Board of Trade; though of steep gradient it does not yet reflect adequately the near-tripled Minnesota acreage. In 1939 North Dakota harvested flax from nearly twice, and South Dakota from nearly four times, as many acres as in 1938.

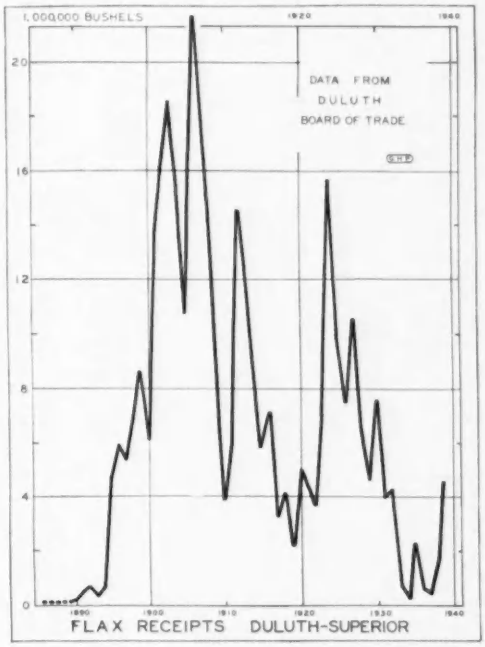

FIGURE 3.—The very wide fluctuation in receipts suggests little concerning any one part of the producing area; low rainfall sections at considerable distances from the port showed relatively more important in earlier periods than recently. In one peak year Duluth-Superior received more than eighty per cent of United States production.

per acre. Flax may give its growers improved working schedules for the year; in Kansas, for example, its seed time comes between that of wheat and that of corn and its harvest after that of wheat and oats.

FLAX RELATIONSHIP TO CLIMATIC CONDITIONS

Germinating flax readily suffers frost injury but after emergence from the soil it is unlikely to experience great damage if temperatures remain twenty-six degrees Fahrenheit or higher; different types of flax vary in frost tolerance, the most resistant selections not succumbing above twenty-one degrees. From early planting, standard varieties need ninety-five days to mature out of danger of fall frost. Planting one week later than desirable for oats seems reasonably safe. After optimum seeding date, in late April for northern United States, each week of delayed seeding reduces seed yield approximately two bushels per acre; for the small acreage of fiber flax late seeding makes for less fiber of relatively poor quality.

More than average vegetative growth appears consequent upon cool nights. In Oregon, having grown slowly to about twelve inches in height, flax may add one inch daily to its length with optimum moisture and coolness. No hot dry winds or extremely high temperatures should hamper blooming, filling, or ripening; such undesirable weather cuts down seed yield and amount and quality of the contained oil.

For satisfactory threshing, air should have so dried flax seed-bolls that the points at their ends stand apart. Plants

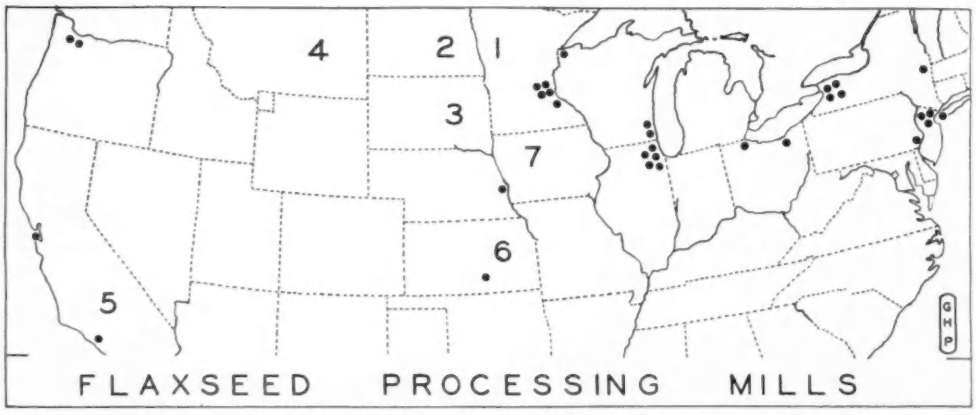

FIGURE 4.—Effect of proximity to producing areas, and influence of Great Lakes route for domestic and of ocean routes for imported seed, all show here. The large digits indicate, for the seven states where they show, rank in flax acreage for 1939. Excepting North Dakota and Iowa, the seven states each more than doubled their 1938 acreages; Wisconsin and Iowa, lesser producers, also more than doubled their 1938 acreages in 1939.

killed by frost, heat, or drought may contain amounts of prussic acid dangerous to animals.

Minnesota shows greater recent flax increase than some of the area lying immediately westward partly because of greater and somewhat more reliable precipitation. In some cases, with an expected two inches' greater rainfall, rate of seeding is stepped up as much as fifty per cent; in other instances, however, with an ample Dakota rainfall, one year's crop paid all expenses including land cost.

Shortage of moisture in flowering and filling stage not only lowers seed yield but results in a lesser quantity and a lower quality of oil. In drought years, reports indicate, along with short yield of seed flax, failure, short crop, or diversion to seed purposes of fiber flax.

Growers desire dry weather seeding to leave the seeds well covered with earth; broadcasting proves satisfactory if a following rain beats the seeds down into the soil. In Kansas flax should receive in excess of thirty inches of rain; this limits hope of successful production to the area lying eastward from the Flint Hills.

Dry weather gives best heading results, the header being arranged to salvage shattered seed. Heads cure best in narrow stacks which minimize heating danger before time for threshing. Tightly tied in binder bundles, flax may spoil if harvested damp, or not fully ripe, or not free from green weeds.

FIGURE 5.—Flax straw not destined for feed but for use in "Klearflax" linen rugs made in Duluth. The stacks accumulated in threshing flax grown primarily for seed.

In some areas of low rainfall, as in southern California, irrigation of flax may prove profitable; its shallow rooting habits indicate frequent light applications of water. Dakotans estimate roughly one bushel per acre seed for each inch rainfall available for the crop; with water under proper control somewhere near maximum yields result.

FIGURE 6.—"Klearflax" factory. This plant yet uses fiber from flax straw, higher grade flax fiber, cotton, and wool in manufacturing a varied line of extremely durable floor coverings.

PESTS

Grasshoppers, if they exist in large numbers, may cause severe losses since they attack the green flax after wheat proves no longer toothsome. Losses show especially heavy in borders of flax fields immediately adjoining those of wheat; here the locusts cut off many immature bolls.

Weeds constitute a problem but are less conspicuous after clean summer fallow, freshly broken sod land, or well tilled crops. Weeds may give so much trouble with a binder or combine as to lead to use of a windrower. After it dries, a pick-up on the combine feeds in the flax with the weeds no longer a great problem. For fiber flax, hand removal of conspicuous weeds precedes pulling. Workmen walk through the three- to five-foot high flax with little injury to the crop. Pulling of flax straw saves most of what would otherwise remain in the stubble. Since 1923 pulling machines expedite this work in Oregon.

VARIETIES

For Minnesota, Buda and Redwing prove most satisfactory. Because of possible loss from rust, Winona does not well suit the southern two-thirds of the state. Bison, a highly wilt-resistant variety, constitutes at times more than eighty-five per cent of the United States acreage and perhaps ninety-five per cent of that in Red Valley.

Though Bison yields less than Linota, its oil yield, of somewhat lower quality, runs significantly higher. Bison lodges more than some other types making harvesting difficult. Because its larger seeds may crack in threshing, a high seeding rate is called for.

DISEASES

Wilt does not pose a problem in areas newly cropped to flax. Decreases in yield after several years of flax growing, formerly ascribed to soil depletion, likely resulted largely from wilt. Rotation, putting flax on the same field not oftener than once in seven years, largely obviates this loss; or flax can appear more frequently in the rotation with safety by formaldehyde seed treatment to insure against wilt. However, resistant varieties, now in common use, mean that the wilt problem no longer menaces so seriously.

SOILS

Some soils tend to crust so that growers using them broadcast flaxseed rather than cover it. Incorporating humus to check crusting and shallow covering of seed seems to be the preferred practice. Fall plowing, where practicable, gives a firm seed bed. Com-

pacting spring plowed fields in limited rainfall areas so that no air pockets remain below the seed bed, though difficult, experienced growers think desirable.

Otherwise satisfactory low-lying bottom lands fields, subject to overflow in spring, thus gain too many weed seeds to invite their use for flax. Farm manures, though otherwise appropriate, may spread so many weed seeds that a tilled crop should precede manured more nitrogen and less of phosphate and of potassium than a crop of either wheat or oats.

MARKETING

As partial compensation for lower yields of hot summer lower middle latitude producing areas, flaxseed may reach the market before high winter prices significantly decline. In the western interior long hauls at high freight rates need compensation by

FIGURE 7.—Stock piles of 1939 baled flax straw awaiting decortication at the "Klearflax" factory. (June, 1940.)

area use for flax. Even for fiber, unless increased quality makes for premium price, commercial fertilizer use usually does not increase net profit.

Most localities report best flax yields on rich fairly heavy soils. However, an excess of alkali salts at the surface may prove disastrous in irrigation areas, and soils may prove too heavy for good drainage thus precluding early seeding. Well-drained clay and silt loams permit early seeding and retain moisture well during growing period. Light sands usually prove undesirable. Whereas Minnesota acreage for 1939 rose to nearly three times that of 1938, the Anoka sand plain, the "Sandland" potato area, showed significant decrease (Figure 1). Despite the traditional reputation of flax as "soil-robber," recent studies show it to use but little high yields or other advantage to keep remote areas in competition. Minnesota growers, though mostly not in the immediate vicinity of the Twin Cities (Figure 2), and averaging even farther from the port of Duluth-Superior (Figure 3), can reach one of these great markets by a comparatively short haul.

Numerous dairy farm growers of flaxseed deliver to mills of their vicinity, from which they buy oil and oil meal at wholesale prices. Such an arrangement serves to explain recent flax acreage increase in Milwaukee vicinity. Mills operate elsewhere within easy trucking range of large numbers of dairy farms (Figure 4). For the attendant economy, producers of flaxseed, so distant as to require rail shipment to market, where practicable, stimulate local volume to make deliveries in full

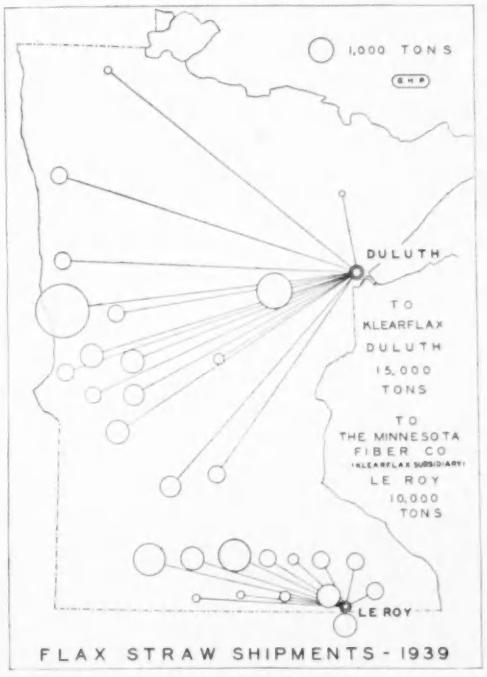

FIGURE 8.—Much of the Duluth and all of the LeRoy fiber currently goes to an eastern United States cigaret paper factory.

car lots rather than in bags or in "combination" cars.

From point of view of the expresser of oil, flaxseed production should be fairly stable, continuous for a long period of years, and large enough in area tributary to a plant for continuous full operation. One mill in Fredonia, Kansas, recent reports indicate, possesses capacity to process an average crop of the entire state in two months' operation. United States seed production needs protection for profit. Tariff schedules of 1929 called for a duty of fifty-six cents per bushel on seed and three and three-tenths cents per pound of oil imported; in 1938 these rates stood at sixty-five, and four and one-half cents, respectively.

UTILIZATION

United States flax industry primarily produces seed. From most of the seed, mills express oil, around two-thirds total value of all mill products; this leaves oil-cake, an important dairy feed. Oil consumption can largely be accounted for by its uses in paint and in linoleum mills and in the printing ink industry.

Feeding value of well-matured flax-straw compares favorably with that of wheat or oats and perhaps stands on a par with prairie hay. Green colored straw or volunteer green growth pasture

FIGURE 9.—LeRoy decorticating plant. This relatively new processing plant serves an area not immediately tributary to Duluth, a section within which flax acreage recently greatly expanded. The shives remain in Minnesota, but usable fiber moves to North Carolina.

prove equally dangerous to live stock. Feed value of straw depends in part upon quantity of seed contained but a large amount of seed induces laxation.

Marketing of straw makes wages for some farmers in an otherwise dull season but gives small net return. Approximately 80,000 tons yearly supply all demands including insulating material, upholstering tow, and coarse wrapping cord (Figure 5). Much of this processing takes place in Minneapolis-St. Paul; a plant in Duluth draws straw from its tributary area for its "Klearflax" rugs (Figure 6).

Recent news items report a $2,000,000 plant at Brevard, North Carolina, making cigaret paper formerly imported. Some 7,500 tons of Minnesota fiber aid in the early production (Figures 7 and 9). California shows recent large increase in flax acreage in its Imperial area and will send significant fiber shipments to eastern paper mills.

Oregon produces considerable high quality fiber. As in most European fiber-producing countries, it succeeds only through subsidy. Oregon growers received, 1936 and 1937, $5.00 and $7.50 per ton of straw delivered at the mill, in federal benefit payments; in the state mill prison inmates perform the great amount of labor required to recover the fiber.

INDUSTRIAL AREA OF NEWCASTLE, AUSTRALIA

Clifford M. Zierer

THE Newcastle area is distinguishable from all other large urban agglomerations in Australia because of its conspicuous dependence upon coal mining and more recently upon steel manufacture. The agricultural output of the fertile Hunter River Valley also has long contributed to the urban development of the area and there is every evidence of Newcastle's becoming more and more the commercial outlet for the great pastoral and agricultural districts of northern New South Wales. Thus the Newcastle area exemplifies in its important urban expansion the magnetic influence of coal upon manufactural development and also the effect of strategic geographic situation upon the focus of commodity movements.

EARLY PENAL SETTLEMENT

The mouth of the Hunter River was observed, in 1797, by a whaleboat party from Sydney bound for Port Stephens in pursuit of runaway convicts. An outcrop of coal in the headland at the mouth of the Hunter (then named Coal River) was especially noted. Soon thereafter a small penal settlement was made on the Newcastle site. In 1802, it was temporarily abandoned because of the difficulty of administering a group so isolated from Sydney. In 1804, the station was re-established and to it were sent those convicts considered too irrepressible to keep in the large general penal colony at Sydney. A much dreaded employment was afforded the convicts at Newcastle in a drift mine opened near water level under Beacon Head. Coal in small quantities was shipped by sea to Sydney and a trade was early initiated with Calcutta—coal being exchanged for Bengal rum.

Exploration of the lower reaches of the Hunter River disclosed large quantities of easily accessible cedar timber. Gangs of convicts were dispatched from Newcastle to raft logs down the river for conversion into lumber and shipment to Sydney. (See Figure 2.)

The attention of "cedar getters" was at once drawn to the fertile alluvial soils in the vicinity of Maitland. As a result convicts for a time were allowed to undertake farming. The difficulties of controlling prisoners engaged in that occupation, however, promptly led to the abandonment of such efforts. Still other prisoners were employed in burning lime from sea shells collected on Stockton Peninsula on the north side of the Hunter mouth. Salt pans were also operated at Fullerton Cove nearby. Although a little coal and lime and "a great deal" of timber were produced

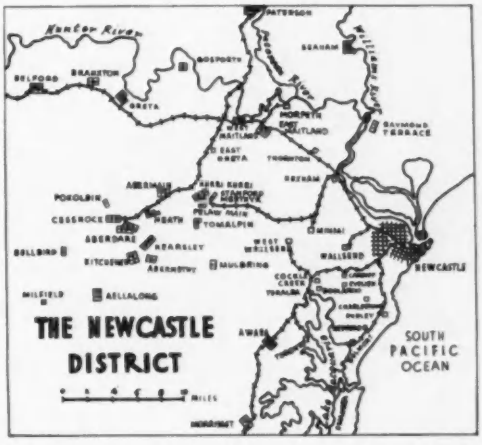

FIGURE 1.—General location map for the Newcastle area.

for export it is to be emphasized that the settlement at Newcastle was designed essentially for the safe-keeping of the convict population which is said to have numbered about 700 in 1818. Nevertheless, a foundation was laid for the entrance of free settlers who arrived in greatly increased numbers after 1821 when Newcastle ceased to be a convict station.

At the close of the convict period the Newcastle settlement was comprised of seven streets containing 13 houses for government officials and 71 houses with additional barracks for prisoners. A shaft 111 feet deep had been opened near the Commandant's house from which 27 men raised 20 tons of coal daily. Timber was being secured from as far as 70 miles up the Hunter River and a route had been discovered along the tributary Goulburn River connecting Newcastle with Bathurst on the interior plains. Owing to the ruggedness of the intervening country intercourse with Sydney was by sea.

AUSTRALIAN AGRICULTURAL COMPANY AND ITS MINING MONOPOLY

An important factor in the development of the Newcastle district at the time when free enterprise began functioning was the Australian Agricultural Company. It introduced large amounts of capital, engaged in exploration, aided immigration, carried on mining, and called attention to opportunities for settlement and investment in New South Wales.

The Australian Agricultural Company was founded in London in 1824 for the purpose of taking up a million acres of land in New South Wales on which fine wool and other farm products were to be grown with the aid of convict labor. Two years later the first contingent of settlers occupied the tract of land selected along the coast a few miles

FIGURE 2.—Newcastle in 1812.

FIGURE 3.—In order to escape floods most farmsteads along the Hunter River are situated along the upland margins. The uplands are devoted principally to pasture, while the river lowlands are devoted to lucerne, with some maize, potatoes, and vegetable crops.

to the north of Newcastle and between Port Stephens and the Manning River. The difficulty of growing fine wool on the coarse coastal grasses discouraged the owners and the company succeeded in exchanging the poorer half of the rough coastal land for more than 550,000 acres of excellent sheep land in the Liverpool Plains district and on the New England Upland near Tamworth.

In 1826, the Australian Agricultural Company was given 500 acres of coal lands at Newcastle along with an essential monopoly of coal mining in New South Wales for some 30 years. The government mines had never been very successful while operated with convict labor and it was believed that they would be more effectively handled by a strong colonizing organization. Certain small independent mines were allowed to continue operation near Newcastle despite the monopoly award. In 1828, the coal land grant was increased to 2,000 acres and within a decade an additional tract of 2,000 acres was purchased. (Roberts, S. H.: *History of Australian Land Settlement 1788–1920*, p. 59.) Gradually the company became more widely known for its coal mining activities at Newcastle than for its agricultural operations. Its principal mine, the "Sea Pit" colliery, was exhausted only in 1914. The position of its large land holding in the midst of the developing city later enabled the Australian Agricultural Company to profit from the subdivision and sale of urban real estate.

Strong public sentiment against the restrictions placed upon coal mining by the "monopoly" led to a cancellation of the "exclusive privilege" in 1847. During succeeding years the coal industry and trade at Newcastle expanded under the stimulus of competitive operation on the excellent Borehole Seam and due to growing markets for coal in the Pacific area.

An early resident described the Newcastle of the 1860's as "a miserable town having one sandy street lined by drab tin and wooden shops and houses, and existing chiefly for the shipment of coal from mines, one of which was only a short distance from the main street." Coal was loaded at the foot of Watt Street at the margin of the business district. Despite the fact that the harbor was relatively shallow and difficult to enter sailing vessels often lay three and four abreast along the wharf awaiting coal. In 1865, coal shipments exceeded 300,000 tons while in 1850 they amounted to only 11,216 tons. Scrub growth covered the sites of present suburbs and it came down from the uplands to Hunter Street, the prin-

cipal thoroughfare paralleling the waterfront. Already a railway connected Newcastle with Maitland situated 20 miles inland amidst the fertile alluvial lowlands of the Hunter Valley. A breakwater connecting Nobby's Island with the mainland enhanced the harbor entrance and Nobby's lighthouse replaced the coal fire which previously had guided ships into the harbor.

EARLY AGRICULTURAL DEVELOPMENT

Agricultural settlement proceeded rapidly along the Hunter River and its tributaries as soon as the lands were made available to free settlers. Settlements clung to the rivers for they were the principal means of transport. Many of the grantees were retired military officers to whom convicts were assigned to operate the large holdings. Grants included sections of river lowland and extended back upon adjoining uplands thus providing grazing lands as well as cultivable tracts. In 1829, the town of Maitland was surveyed to serve the growing agricultural community. Other rural towns followed. By 1835, most of the desirable land had been alienated. (Roberts, S. H.: *History of Australian Land Settlement 1788–1920;* Map on p. 28a.)

FIGURE 4.—Hunter River at West Maitland, showing dike to protect the town during flood discharge. Dikes are necessary also to protect the low lying farm lands in the district.

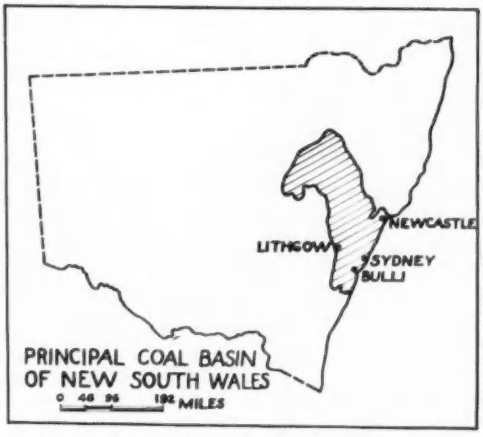

FIGURE 5.—Relation of Newcastle to the principal coal basin of New South Wales. Lithgow and Bulli are other important coal producing districts.

Wheat farming occupied the lowlands up until 1865 when rust drove it out of the moist coastal belt. Flour mills were to be found in all the towns of the valley. Like the early land grants the towns were situated along the rivers despite the flood hazards. During severe floods the lowlands between Newcastle and Maitland "resembled an inland sea." Farm homes were situated on artificial mounds or at the margins of the upland. Products of farm and range were assembled at Morpeth, the head of navigation on the Hunter River for export. (Mauldon, F. R. E.: *A Study in Social Economics—The Hunter Valley, N.S.W.*, pp. 32–33.) Smaller boats were able to proceed to Paterson and Clarencetown which marked the limits of water transport on the Paterson and Williams rivers, respectively.

The coming of railways altered many of the commercial relationships established in the days of river transport. For example, Maitland, at an important railway junction later became the principal rural market center while Morpeth, at the end of a spur railway line, suffered a notable decline. The Hunter River, it should be noted, is not an

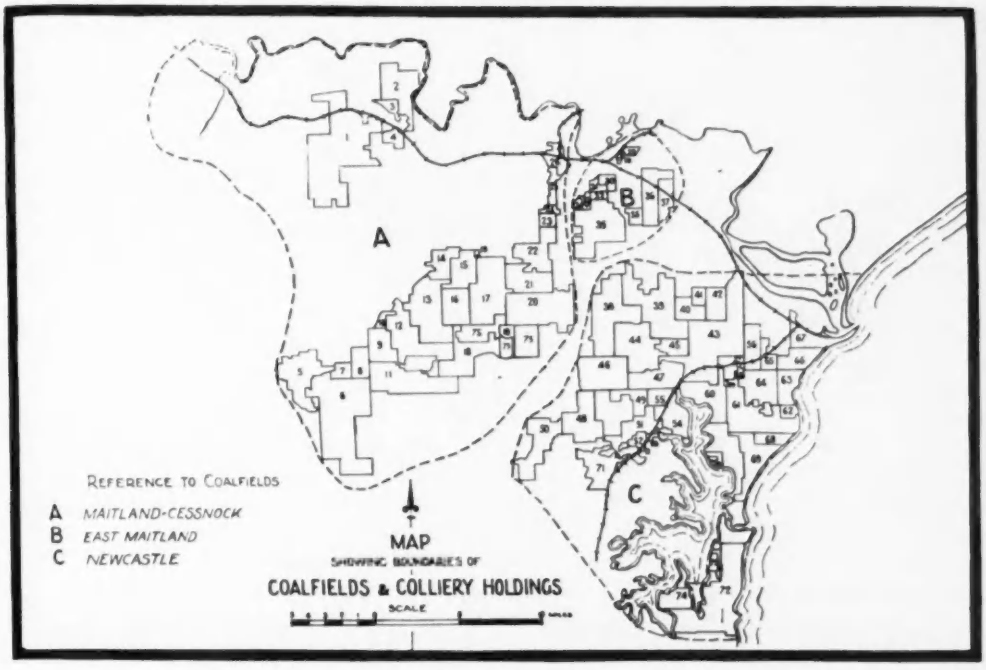

FIGURE 6.—Colliery holdings in the Newcastle and Maitland coal fields.

easily navigable stream. Below the mouth of the Williams River it is a broad meandering channel through a mud flat. At the mouth of the Paterson River it is a suitable channel for small launches. At Maitland it is a mere creek.

DEFINITION OF THE NEWCASTLE AREA

The Newcastle industrial area may be defined roughly as the lower Hunter River lowland (extending 25 miles inland to include Maitland), along with the coal fields to the south and southwest. (The area is shown on the Newcastle, Paterson, Cessnock and Singleton sheets of the Military Survey of Australia. [Scale 1:63,360].) An area of less than 1,000 square miles is involved (Figure 1). The dominant cultural feature of its landscape is the extensive but interrupted pattern of urban development. Newcastle and its immediate suburbs comprise the largest aggregation with more than 100,000 inhabitants. About 50,000 persons are included in the urban belt extending southwest from Maitland across the Maitland Coal Field. Numerous small towns are spread over the Newcastle Coal Field. Most of 200,000 persons reside in urban congeries within the Newcastle area and only a few thousands are engaged primarily in agricultural pursuits.

Topographically the area consists of two strongly contrasting divisions—the northern alluvial lowlands and the southern uplands. Large portions of the estuarine and river lowlands are marshy or subject to tidal influence. On the alluvial islands and shores of the estuary the mangrove and swamp oak (*Casuarina glauca*) are characteristic. The better drained parts and those sections protected by dikes are divided into small holdings of 20–40 acres and devoted largely to lucerne production.

Irrigation water is pumped over the dikes from the river.

Bolwarra Flats and the lands in Phoenix and Down parks to the east of Maitland are not excelled in fertility and in agricultural productivity in Australia. Most of the cultivated land lies beneath the 25-foot contour line. But the crop lands constitute only a few square miles in comparison with the much larger areas of unused swamp. The extent of productive agricultural lands in the lower Hunter River Valley is easily exaggerated.

The southern upland rises 200–400 feet above sea-level and has been maturely dissected by numerous small streams. The infertile and droughty sandstone soils of the coal measures have produced a scrubby eucalyptus forest which still covers most of the surface. Only along the main stream courses does one find scattered patches of cultivated land and belts of partially cleared pasture. Collieries and associated settlements usually occupy small clearings with the closely fringing "bush" on all sides. (Maze, W. H.: Land Utilization in the Lower Hunter Valley, N.S.W., Australia: *The Australian Geographer*, Vol. 2, 1934, Nos. 2 and 3. Contains land utilization maps of the Paterson and Cessnock quadrangles.)

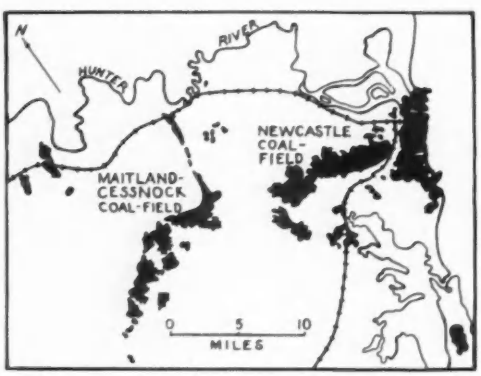

FIGURE 7.—The portions of the Newcastle and Maitland coal fields actually worked are shown here.

FIGURE 8.—Large, modern colliery in the Maitland coal field at Cessnock.

NEW SOUTH WALES COAL BASIN

The principal coal basin of New South Wales occupies an unusually strategic geographic position (Figure 5). It occurs in the form of a great arc fronting along the eastern seaboard for a distance of about 150 miles between Port Stephens on the north and the Shoalhaven River on the south. Sydney lies approximately in the center and deepest part of the basin, the uppermost seam being nearly 3,000 feet below sea-level. From Sydney the coal seams rise gradually but irregularly to the north, south, and west outcropping in the vicinities of Newcastle, Bulli, and Lithgow at elevations of 200 feet, 1,400 feet, and 3,000 feet, respectively. In those peripheral districts of outcrop are situated the principal mining centers. In general New South Wales coal is well situated with respect to present and probable future population in Australia, but producing centers, except for Newcastle, are somewhat removed from the principal foci of population.

About three-quarters of the Australian reserve of recoverable coal is situated in New South Wales. The remaining quarter is distributed widely among the other states most of which are dependent upon New South Wales for at least a part of their coal requirements.

The Newcastle district is by far the most important coal producer in Australia, being responsible for about half the Commonwealth output. About two-thirds of the New South Wales coal comes from the Newcastle area and within a radius of 40 miles of the port. Two principal coal fields occur there—the Newcastle Field and the Maitland Field. The former extends twenty miles to the south and west of Newcastle. The Maitland field is situated some 30 miles inland (Figure 6).

The development of the Lower or Greta coal measures was undertaken first in 1890, but largely since 1900. The Greta seam, with 14–32 feet of coal, has now surpassed the Borehole seam in annual output. Large modern collieries characterize the newer Maitland Field, some producing 2,000 tons daily from the Greta seam. Smaller collieries are most numerous in the older Newcastle Field. A dozen large operators in the Newcastle area together produce about 40 per cent of the Australian output of coal and two of them alone produce nearly 20 per cent.

FIGURE 9.—Characteristic settlement grouped about a mine in the Maitland coal field. Scrub eucalyptus forest borders the town on the upland side, while partially cleared pasture land is characteristic of the lower lands.

The Upper or Newcastle coal measures are most widespread in the area and they contain a total thickness of 35–40 feet of coal. The Borehole seam with a thickness of 5–20 feet was the first to be exploited extensively and was responsible for the early development of Newcastle as a major coal shipping center. The Borehole seam has produced more coal than any other seam in the district. The Burwood seam is second in importance in the Newcastle Field.

Coal from the Greta seam, or Maitland Coal as it is called commercially, is the most desirable coal for general purposes and is now the basis for both the interstate and foreign coal trade of Australia. It is especially desirable for gas manufacture as it contains 45 per cent volatile material. It also is a good steaming coal for railroads and ships as it burns fiercely. Coal from the Borehole seam is better suited for

FIGURE 10.—Railway trucks filled with coal awaiting shipment by water at Newcastle harbor.

coking as it has 50–55 per cent fixed carbon but it is likewise considered to be a good steaming and export coal.

Natural conditions are generally favorable for coal mining in the Newcastle District. Most of the collieries in the Maitland district are situated near the outcrop of the Greta seam. Shallow shafts and tunnel openings give access to the coal beds. Seams are of good thickness and generally horizontal. Pumping for drainage is not excessive.

Increasing use is made of mechanized mining methods in the Newcastle area. About one-fourth of the coal is now cut by machinery. Animal haulage is more widespread than motor transportation underground.

Early miners from Great Britain are responsible for having introduced the room-and-pillar mining system which dominates the district. Names of collieries and mining towns, likewise, present a mixture of appellations transferred from the British Isles including the names Newcastle and Northumberland County.

Since there are no significant seasonal variations in demand for coal in Australia, because of the mild climate, steady activity of the mines is facilitated. Likewise, there is usually a steady movement of coal to markets in all seasons, thus using transportation equipment to its full capacity. Relatively small amounts of coal are consumed in Australia for domestic heating.

Since 1860, coal rights usually have been reserved by the government and the reservation policy is now firmly established as a national policy. Public ownership has resulted in a greater opportunity for regulation of mining methods and for safeguarding the interests of workers. Royalties averaging 6 d. per ton are assessed and the maximum area allowed a colliery is 4,480 acres. (Report of the Royal Commission on the Coal Industry; N.S.W. Legislative Assembly 1929–30, p. 66.) The strong position of labor and rigid public regulation have at times greatly handicapped the industry in its foreign competitive ability. (See Figure 7.)

Most companies operate single mines but several companies have from two to eight collieries each. A close association is had between numerous colliery companies and brick yards, coke oven plants, power plants, cement factories, steel works, and interstate shipping lines. (Mauldon, F. R. E.: The Economics of Australian Coal, pp. 76–78.) Defensive organizations among colliery owners offset strong workers' unions.

Too many mines with productive capacity in excess of recent market needs has led to intense competition and to wastes in mining. Much more than half the coal is left in pillars in thicker seams. The scattered distribution of population centers in Australia makes mine-mouth power plants and interconnected power systems difficult to establish. Development of power on the Newcastle coal fields and its transmission to the large Sydney market, however, would be relatively easy.

MAITLAND COAL FIELD

The development of the Maitland Coal Field has created a new and extensive industrial district some twenty-five miles inland from Newcastle. A succession of large and small coal mining communities stretches for more than 20 miles along the outcrop of the Greta seam between Maitland and Milfield. A succession of large collieries was opened after 1900 and each led to the establishment of a new town. Kurri Kurri, Stanford, Merthyr, Pelaw Main, Abermain, Neath, Aberdare, Cessnock, Kearsley, Abernathy, Kitchener, Bellbird, and others comprise a closely spaced belt of mining towns.

Before the exploitation of coal the district did not contain 500 people, while, in 1933, the population of the district was approximately 50,000. Cessnock grew from a village of 165 persons in 1901 to a city of 15,000 in 1933. All of the towns are dependent wholly upon the mines and their welfare ebbs and flows with mine activity. Most of the settlements are situated on the coal measures thus often interfering with final mining operations and pillar extraction.

A system of about 100 miles of privately-owned railways serves the Maitland Coal Field. Connections are made with the State Railways at several points and with tidewater at Hexham, some ten miles above Newcastle on the Hunter River.

Special rail connection is provided between both the Newcastle and Maitland coal fields and the more extensive coal marshalling yards and export docks at Newcastle. This was essential in order to prevent additional congestion on the main railway line serving Newcastle. The latter along with associated shops and yards has long suffered from its cramped position along the narrow waterfront between the river and the business district of Newcastle. Completion of a project to move the railway

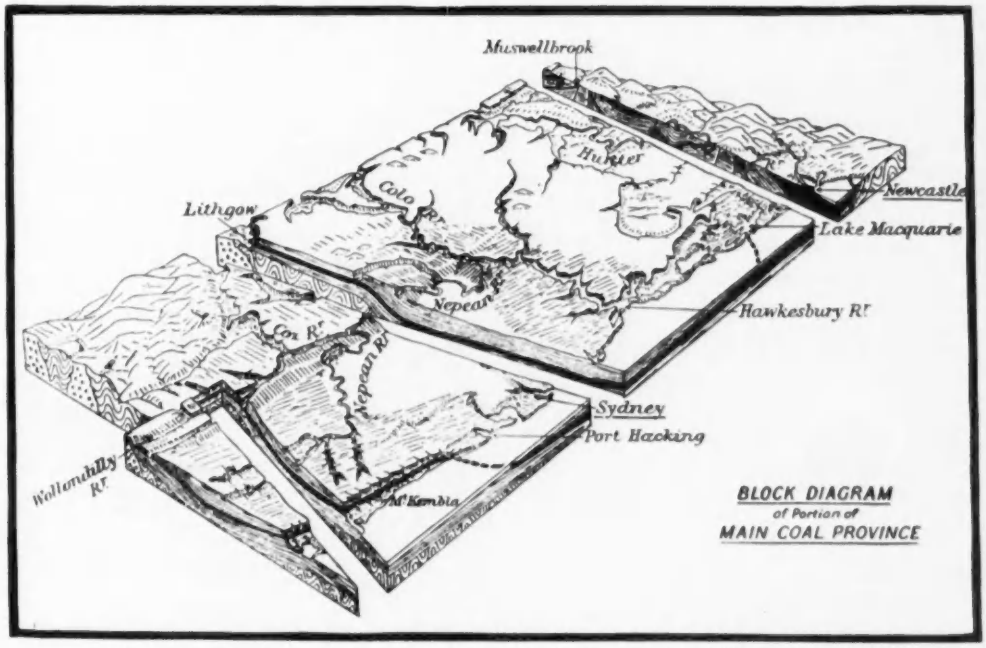

FIGURE 11.—Outline and structure of the principal coal field of New South Wales.

FIGURE 12.—Numerous abandoned mines are to be seen in the Newcastle coal field. In some instances small amounts of pillar coal are produced for years following the cessation of major operations. Bordering lands are devoted to permanent pasture.

shops and freight yards to the extensive lowland at Broadmeadow several miles inland will notably relieve railway congestion and noise in the business district.

DECLINE OF COAL TRADE AT NEWCASTLE

The mining industry of the Newcastle area was until recently almost entirely dependent upon the shipment of its products to other centers. The establishment of steel industries in 1915 suddenly created a large local market. The appearance of manufactural industries at Newcastle was most opportune for the long-established coal trade was gradually diminishing due to a number of reasons.

Newcastle enjoyed for many decades a large export trade principally to countries bordering the Pacific. At the peak of the trade 30 per cent of New South Wales coal left the country as bunker and cargo coal. Exports dropped from nearly 3½ million tons in 1913 to 1 2/3 million in 1927 and to less than 2/3 of a million in 1930. A slight recovery has taken place since that time. Some importing countries have developed coal supplies of their own or have turned to fuel oil. The opening of the Panama Canal made the west coast of South America accessible to new sources of fuel. The general substitution of oil for coal for ocean transport and the increased competition of South Africa and India in the bunker trade also contributed to the decline of Newcastle's foreign shipments in recent decades.

The principal market for Newcastle coal has always been the Commonwealth itself. Twice as much New South Wales coal goes to other states as is exported. Victoria and Tasmania lack high quality coal and South Australia is entirely dependent on outside sources.

In recent years Newcastle has lost certain large Australian markets. Victoria had long been an especially good customer, but owing to occasional interruptions in the Newcastle supply due to extended strikes and because of a long-felt desire to become more nearly self-sufficient, that state engaged in large-scale power production from lignite in 1919. Enormous quantities of lignite at shallow depth occur about 100 miles east of Melbourne. Open-pit machine mining and conversion into electricity on a large scale enabled the Yallourn plant to supply power not only to Melbourne but to many other parts

FIGURE 13.—Most old type coke ovens in the Newcastle district have been abandoned. Most coke is now manufactured in that district in connection with the operation of the steel works.

of the state at attractive savings. Large quantities of lignite briquettes are being manufactured to meet the needs of domestic heating. It is probable that in the future artificial gas will be made at Yallourn and piped to Melbourne thus eliminating a choice market for Maitland coal. The electrification of the suburban railway system in Melbourne resulted in the loss of another important market for Newcastle coal. Despite the fact that much high-grade Newcastle coal still moves to Melbourne for industrial and domestic uses the shift to lignite was a serious blow to the Newcastle mining industry.

The large state hydro-electric undertaking in Tasmania caused other losses of market for Newcastle coal in recent years. Although the substitution of imported fuel oil for coal has not proceeded far in stationary power plants in Australia, large Diesel installations at Broken Hill and Port Pirie are another cause for decline in coal markets.

The coal industry in Australia has suffered from high production costs. Excessive capitalization of mines, and high labor costs have made it increasingly difficult for Australian coal to compete in foreign markets. Expensive coal likewise handicaps production of all kinds in Australia through higher transportation, power, and fuel costs.

FIGURE 14.—Hunter Street is the principal commercial thoroughfare in Newcastle. It parallels the waterfront closely in this section.

FIGURE 15.—A better residential street in one of Newcastle's newer suburbs (Hamilton). Brick houses with tile roofs are characteristic in the newer suburbs.

Australia's primary products are hauled to the seaboard and then to some foreign markets with Australian coal. Effective production and utilization of Newcastle coal, therefore, strongly influences the entire commercial and industrial structure of the Commonwealth. Australia is especially dependent on coal for power and heating purposes owing to its lack of petroleum resources and its scant reserves of water power making it imperative that Newcastle coal function effectively.

COKE MANUFACTURE AT DIFFERENT PERIODS

Coke manufacture in the Newcastle area began in 1861 when beehive ovens were erected in Minmi, ten miles west of Newcastle. Later others were constructed at Wallsend. Wallsend coke for many years was sent to Port Pirie, S. A. for use in the smelters. In recent years most of the older beehive ovens in the area have been abandoned. The superior quality of Bulli coke led to the establishment of more important coking plants in the South Coast or Bulli Field than in the Newcastle area. Borehole, Burwood, and Greta coal have 50–55 per cent fixed carbon but Bulli coal has 65 per cent.

In 1915, the opening of the B.H.P. by-product coking plant enormously increased the coke output in Newcastle.

A mixture of 80 per cent Borehole and 20 per cent Burwood coal is commonly used in the ovens. The resulting coke is too friable for long hauls but is suitable for local blast furnace purposes. Some coal is carried to Newcastle from the South Coast Field to improve the quality of coke for special metallurgical uses. Greta coal is used at the steel works for gas manufacture and for steam development.

NEWCASTLE'S STEEL INDUSTRIES

Although it had often been predicted that Newcastle would at some time become a center of important manufactural activity it was only in 1915 that the district acquired a plant of great national importance. The ease of transporting Newcastle coal by sea to Sydney (60 miles distant) and to other large population centers militated against the establishment of manufacturing industries on the coal fields. Newcastle displayed practically a stationary population of 50,000 at the census years 1891, 1901, and 1911. The establishment of the steel works of the Broken Hill Proprietary Company and the rise of important subsidiary plants promptly gave a characteristic stamp to Newcastle's new industrial activity.

FIGURE 16.—A view across the Adamstown lowland, one of the residential suburbs of Newcastle. Uplands in the distance as well as in the foreground have never been cleared.

FIGURE 17.—Blast furnaces at the Broken Hill Proprietary Company steel works.

Its population rose to 85,000 by 1921 and to 105,000 by 1933 under the stimulus of manufactural growth. The city has become sufficiently specialized as an iron and steel center to experience serious depression when the plants are not active. The muffled roar of tremendous outbursts of steam from the rolling mills is audible from most parts of Newcastle and immediate suburbs both day and night. Since the steel plant is a most important user of coal (consuming about a million tons yearly) the mining industry responds closely to trends in steel production. Thus the district's two chief industries act together in their effect on local employment and economic well-being.

The selection of Newcastle as the site for the B.H.P. steel plant came as a result of careful and deliberate consideration of the relative advantages of several possible locations. Close proximity to large supplies of suitable coal was the prime consideration in Newcastle's choice. A seaboard position to provide cheap access to South Australian iron ore and Tasmanian limestone was essential along with similar access to Australia's widely spaced markets for finished goods. Site factors such as a sufficient amount of cheap land, abundant supplies of water, a well protected and ample harbor, and con-

venient residential areas for workers were easily arranged at Newcastle. Waratah, Mayfield, and other suburbs convenient to the steel mills have made rapid growth. The water front at Port Waratah, from which coal was once dispatched, afforded a large tract of land adjacent to Newcastle's developed harbor. The B.H.P. acquired a portion of the land at Waratah as early as 1896 for the erection of proposed smelters to be used in connection with their Broken Hill mines. Dredging of the silted channel enabled large vessels to reach the site. River dredgings were utilized to raise the level of the marsh. The only other site (Port Kembla) which compared favorably with Newcastle has since been occupied by the Australian Iron and Steel Company. There, too, good coking coal is situated on the ocean front but much less space is available for extensive urban development.

Following the establishment of blast furnaces and rolling mills the B.H.P. promptly extended its operations to the production of railway materials, and sheet, wire, and pipe products to meet Australian needs. Thus a group of large metal manufacturing plants appeared in Newcastle adding greatly to industrial employment, increasing the demand for local coal, and contributing notably to the prestige of Newcastle as a steel center.

Several other small plants fabricate steel products such as rabbit traps, agricultural implements, and building hardware. The large Walsh Island Ship Yard was established at Newcastle by the State in 1913 when the Commonwealth took over the Cockatoo Island Works in Sydney harbor. While the plant shared in the ship building program during the World War it has operated only spasmodically in recent years. The plant is situated on an island in the Hunter River opposite the steel works.

FIGURE 18.—Piles of shells and sulphur along a railway siding at the important cement and fertilizer works at Cockle Creek.

THE COCKLE CREEK INDUSTRIAL CENTER

The large plant of the Sulphide Corporation was established at Cockle Creek in 1896 for the treatment of zinc ores from Broken Hill by electrolysis. The plant is situated at the edge of a lowland created by the deposit of silt by Cockle Creek in the northernmost arm of Lake Macquarie. Although Lake Macquarie is essentially an arm of the sea it is not navigable for larger vessels and thus the works are accessible only by land transport.

Not proving successful the plant was

FIGURE 19.—Lumber mills along the waterfront at Newcastle.

next devoted to the smelting of lead, silver, and gold ores largely from Broken Hill. In 1923, the plant was closed due to the inability to secure the required tonnages from associated mining properties for efficient operation. From that date the smelters at Port Pirie, S. A. undertook to smelt practically all ores produced at Broken Hill.

In 1924, arrangements were made for preliminary roasting of zinc concentrates from which operation sulphuric acid was secured as a by-product. The latter was applied to phosphate rock obtained from Nauru and Ocean Islands for the manufacture of super-phosphate fertilizers. Large quantities of phosphate are utilized by wheat growers throughout Australia and also as a top-dressing on some pasture lands. Texas sulphur is now utilized for acid manufacture. Another portion of the large plant was recently devoted to cement manufacture from limestone secured at Attunga (200 miles distant by rail) and from local clay.

Obviously all the activities carried on at Cockle Creek have been attracted to the Newcastle area by the easy access to coal. However, the situation of the plant more than ten miles inland would seem unfortunate when more eligible sites could have been found on the water front. A special dock is reserved in the Newcastle harbor for the transfer of incoming phosphate rock, sulphur, zinc concentrate and other raw materials to railway cars for delivery to the plant.

MINOR INDUSTRIES IN NEWCASTLE AREA

Clay industries manufacturing brick, roofing tile, and sewer pipe are situated in half a dozen suburbs on the sites of clay deposits. Brick is the commonly used structural material for the better commercial and residential buildings in Newcastle. Roofing tile is replacing corrugated iron on many newer homes. Silica fire bricks for use in the steel mills are made at Waratah and at Thornton midway between Newcastle and Maitland. Rock for concrete and highway material is quarried at Teralba and Fassifern on the margin of Lake Macquarie. By-product tar from the B.H.P. coke plant is widely used as a binder in road surfacing instead of depending on imported asphalt. Large quantities of crushed slag are used for road building, as railway ballast, and as a matrix for concrete in the Newcastle area. A large electric lamp works is situated in one of Newcastle's suburbs. The usual assortment of food preparation plants to serve the Newcastle area are to be found principally within the compactly settled port district.

WATER AND POWER SUPPLIES ADEQUATE FOR INDUSTRY

Contributing factors to the establishment of manufacturing industries in the Newcastle area have been adequate water and power supplies. As early as 1893, the Hunter District Water Supply and Sewerage Board was organized to serve the Newcastle area.

Water is now obtained from an upper tributary of the Williams River and stored in Chichester Reservoir some 60 miles north of Newcastle. The reservoir has a storage capacity of five billion gallons and its watershed receives nearly twice as much rainfall as Newcastle. In times of serious drought the Hunter River is used to supplement the supply. A plan is under consideration for extending the supply by pumping ground water from the coastal plain between Newcastle and Port Stephens.

A population of nearly a quarter million is served by the Hunter District Water Supply. Fifty-seven per cent of 3,931 million gallons supplied in the year ending June 30, 1937 was utilized for domestic and related purposes. Large industrial consumers, as the steel works, railways, collieries, shipping, breweries, and factories, used the remaining 43 per cent. The steel works alone utilized 959 million gallons or one-fourth of the entire supply. Most mines, the electric power stations, abattoirs and several factories have private supplies.

In connection with the operation of electric tramways the New South Wales Railway Commissioners established a large power plant on the water front at Newcastle. Abundant supplies of cheap coal from nearby mines and the use of sea water for condensing purposes make for economical power production. Large amounts of surplus power are available to industries and to municipalities within a wide radius. Efforts have been made to attract new industries to Newcastle by the offer of cheap electricity in bulk quantities.

NEWCASTLE AS AN EXPORT CENTER FOR AGRICULTURAL PRODUCTS

In July 1918, a decentralization conference was held at Newcastle at which time resolutions were passed urging the State and Federal governments to

FIGURE 20.—Mangrove covered islands and mud flats in the lower Hunter River a short distance above the improved river harbor at Newcastle.

encourage shipments of wool, wheat, meat, and butter through Newcastle. Essentially no wool and butter was being exported through Newcastle at that time and most wheat and meat shipments also moved to Sydney. Unquestionably the close proximity of the larger port which was more certain to provide export cargoes strongly handicapped the development of general cargo business at Newcastle. Newcastle's rank as the third port of the Commonwealth was based almost entirely on its large trade in coal and in the raw materials and finished products of the steel industry.

Nevertheless, certain geographic conditions invited the establishment of export facilities for agricultural products at the mouth of the Hunter River. Ready access with the interior plains was available through the broad Cassilis depression (elevation 1,600 feet) between the Blue Mountain and New England uplands. All of the fertile lands of the North Coast rivers and of the New England upland were closer to Newcastle than to Sydney by nearly 100 miles. The feeling that the northern portion of New South Wales is handicapped by commercial dependence on far-away Sydney has been so strong in recent years that the creation of a new state has been urged with some suitable northern port city as the new capital. Should such a scheme be put into effect and should Newcastle be selected as the governmental center its commercial expansion would be assured.

EARLY CENTRALIZATION OF COMMERCE IN CAPITAL CITIES

Railway construction began at Newcastle about as early as at Sydney. By 1870, Newcastle was connected with Muswellbrook in the Upper Hunter Valley. Lines were extended to the Queensland border over the New Eng-

FIGURE 21.—Eucalyptus piles and sleepers awaiting shipment on the extensive wharves bordering the river. The steel plant is seen in the left distance and a shipyard, located on an island in the river, is visible at the right.

land upland and to the Northwestern Slopes by 1887. All the trade of that territory by necessity came to Newcastle for there was no rail connection with Sydney. After Sydney secured railway contact with Newcastle and with the northern part of the state it rounded out its control of the export trade of the whole of New South Wales. Wool ceased to move out through lower Hunter River ports like Morpeth and Newcastle. The Newcastle district in the decades which followed failed to expand along commercial lines in proportion to the development of its normal hinterland. The policy of centralizing commerce and secondary industries in the capital cities, which became characteristic of all the Australian states, did not provide for supplemental ports or competitive population centers.

HARBOR FACILITIES AT NEWCASTLE

Newcastle harbor is sheltered from southeast winds and from southerly moving currents by artificial breakwaters. The harbor entrance is a thousand feet wide with a dredged depth of 25½ feet at low water. The tidal range is only three feet. General cargo wharves parallel the south bank of the river for about two miles within stone's throw of the elongated business district. Wool, meat, butter, zinc, calcines, and many other items are handled over those wharves.

North across the channel on the Carrington Peninsula are located the principal coal handling docks. A mile-long dike along the river bank served as the principal coal shipping center prior to 1914. Constant silting of the river channel led to the dredging of the south-facing basin which has since become the center of the coal trade. Large cranes lift the 8–16 ton hoppers from the railway trucks dumping the coal into the holds of vessels. The new State-owned wheat export terminal occupies a position adjacent to the basin and several lumber mills are situated on the west side of the Carrington Peninsula.

BULK WHEAT HANDLING FACILITIES

Wheat is the principal agricultural crop in New South Wales occupying about three-quarters of the cultivated acreage. Although the principal producing districts are in the Riverina and southwestern slopes tributary to Sydney and Melbourne large quantities are grown on the central and northwestern slopes readily accessible to Newcastle. The harvest period begins in November and most of the crop intended for sale is sent to the railway for transport during December and January. Since only a fraction of the product can be consumed in New South Wales and since interstate trade in wheat is small, owing to the self-sufficiency of other states, large quantities are available for export overseas.

FIGURE 22.—The large new state-owned bulk wheat terminal at Newcastle is contributing notably to the significance of that port in overseas trade.

In the past all Australian wheat was sent to market in three-bushel bags, but, in 1917, the Federal Government was empowered to finance states in the construction of bulk wheat storages and export facilities. New South Wales promptly took advantage of that offer and a portion of the 1920–1921 crop was

handled in bulk through a system of country elevators and a large export terminal at Sydney. Steady extension of the elevator facilities in the wheat growing districts was made and an export terminal with a capacity of 800,000 bushels was completed at Newcastle in time to share in handling the 1936–1937 crop. The establishment of the Newcastle elevator was an important step in the direction of decentralizing the export of primary agricultural products in New South Wales.

FIGURE 23.—The Newcastle abattoir is situated on a flat upland near the river and is bordered by extensive paddocks in which stock may be held until needed.

WOOL EXPORTS FROM NEWCASTLE

New South Wales has about half the total number of Australian sheep. Ninety per cent are Merino and wool production is the primary objective of the industry. Although the capital cities are more important wool handling centers, Newcastle, since 1929, has gained steadily as a sales and export point. In 1929, wool sales at Newcastle amounted to 8,522 bales while in 1935 they involved 37,786 bales.

Newcastle attracts a portion of the wool produced in the northeastern part of the state although the bulk still moves to the much larger Sydney market. Wool sales begin in September and continue for about six months on fixed dates. Representatives from the great wool-buying nations attend the sales. Most Australian wool is exported as greasy wool in bales weighing about 300 pounds each. Four small wool stores are situated near the water front and are capable of accommodating 40,000 bales.

MEAT INDUSTRIES AND TRADE

The Newcastle municipal abattoir, situated at the northwest margin of the metropolitan district and along the south channel of the Hunter River, dominates that branch of industry locally. Created by Act of Parliament and beginning operations in 1916 it automatically closed 35 small slaughterhouses within a 14-mile radius of the central city. Within that radius all slaughtering and inspection are performed by the Newcastle District Abattoir Board. Outside that limit slaughtering is done in private plants under the inspection of local authorities.

For twenty years after its establishment the abattoir was concerned chiefly with supplying meats for the 15 local municipalities served by the organization. Recently stock raising interests in northern New South Wales have found it advantageous to have their animals processed and exported through Newcastle. Extensive grassy paddocks, containing a scattered growth of eucalyptus trees, provide abundant space for holding cattle and sheep and lend a spacious rural aspect to the undertaking.

Aberdeen in the upper Hunter Valley with nearly a thousand inhabitants is the headquarters of a small chilling and freezing works which caters to the export beef and mutton trade. Several small plants occur in the Hunter Valley for freezing rabbits for export.

Storage and shipping facilities for the export trade are available at Newcastle. With three-fifths of the cattle of New South Wales in the northern portion of the state and with increasing

emphasis on the production of fat lambs it is reasonable to expect an increased export movement of meat products through the port of Newcastle in the future.

Closely associated with the meat trade is the storing and export of dairy and poultry products. The north coast of New South Wales is an outstanding dairy region. Increasing quantities of butter are moving to export markets through Newcastle as the most accessible large port. A few large commercial poultry farms are situated in the Maitland district. Considerable attention is being given to hog raising in the dairy districts and bacon factories occur in several inland towns tributary to Newcastle.

WORKSHOP FOR THE COMMONWEALTH

While all the larger cities of Australia contain a markedly larger proportion of women than of men, Newcastle alone possesses approximately equal numbers. Newcastle with its mining interests, heavy industries, and shipping activities is clearly "a man's town."

Newcastle lacks the qualities which lend a metropolitan character to the capital cities. Even the managerial offices of many of Newcastle's principal industries are located elsewhere. Newcastle is a city of workers. Its retail establishments cater to the needs of that class. Luxuries and elaborate architectural displays are in little evidence.

The very site of Newcastle does not lend itself to an ornate urban creation. Coal and iron are not the materials to form an attractive cultural pattern. Newcastle is the workshop of a Commonwealth. It is likely to retain those distinctive urban qualities.

PINTO BEANS IN THE ESTANCIA VALLEY OF NEW MEXICO

James I. Culbert

THROUGHOUT most of the United States "bean" means the common or navy bean, chief constituent of the famous New England dish, Boston Baked Beans, but in the southwest it refers to the frijole, the pinto bean of commerce. Frijoles are larger than navy beans, are light ivory in color and have reddish brown spots. When cooked, they become a rich red brown over all. They have long been a staple food among the Spanish speaking population of southwestern United States, but are little known in eastern markets.

From the standpoint of acreage, pinto beans are the fifth most important crop in the state of New Mexico, being preceded by sorghum, wheat, corn, and hay, in the order named. Seven hundred and thirty-six thousand acres are devoted to production of grains, 159,000 to hay, and 154,000 to beans. Of these 154,000 acres, approximately 78 per cent, or 120,000, lie in or near the Estancia Valley, making this by far the most important bean producing region in the state.

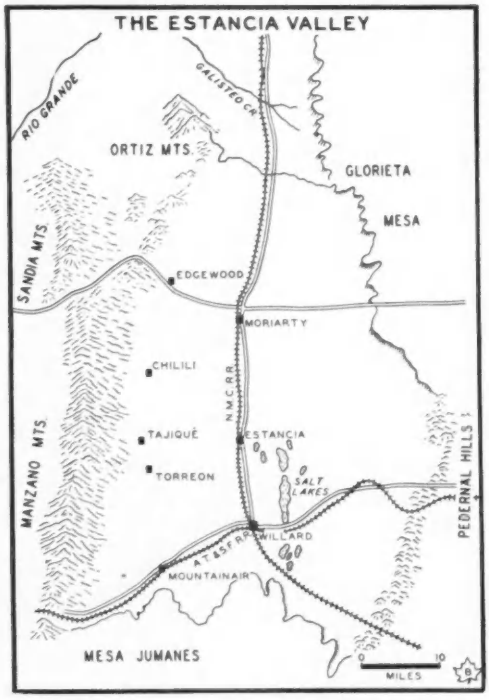

FIGURE 1.—Index map of the Estancia Valley.

GEOLOGY AND PHYSIOGRAPHY

The Estancia Valley, sometimes called the Sandoval Bolson, is a prominent representative of the bolsons so common throughout the Basin and Range Province of western United States. It is located in approximately the geographic center of New Mexico, south of Santa Fe, and east of Albuquerque. A depression, having no outlet, it is 65 miles from north to south, and 40 miles from east to west, with an area of approximately 2,000 square miles.

On the west, the valley is separated from the Rio Grande by the Manzano Mountains, a fault block which forms an unbroken range from north to south, and attains an elevation of 9,000 feet or 3,000 feet above the valley floor. The core of these mountains consists of a series of granites, schists, and quartzites, which were probably thrust up near the close of the Cretaceous. These rocks dip steeply to the east, and overlying them, a massive limestone with a less pronounced dip, continues eastward under the more recent formations of the valley floor.

A hilly upland connects the northern end of the Manzanos with the isolated

laccolithic peaks of the Ortiz and San Pedro Mountains to form the northwestern border of the depression; while on the north, the valley breaks off in an escarpment overlooking Galisteo Creek. The much dissected margin of Glorieta Mesa, a divide of horizontal rocks, forms the northeastern boundary.

The Pedernal Hills, an undulating mass of granite, schist, and quartzite, separate the basin from the Pecos Valley, and the bolsons of Encino and Pinos Wells, which lie to the east. These low, rugged hills, rising above a tableland, are probably composed of the same formations as the Manzano Mountains. On this side of the valley, limestones and sandstones, similar to those on the west, lie in almost horizontal attitudes.

On the south, the 500 foot escarpment of the Mesa Jumanes separates the valley from Tularosa Basin.

The hard rock floor of the valley is deeply covered with material which has been washed down from the highlands. In the vicinity of Mountainair, wells drilled to a depth of 500 feet have not entirely penetrated these alluvial deposits. The alluvium is composed chiefly of clay, in which are interspersed numerous stones ranging in size from pebbles to great boulders. Near the mountainous border large stones are common, but they decrease in size with increasing distance from the highlands, and are entirely lacking in the center of the valley where deposits of pure sand and clay are to be found.

So gentle is the slope from the surrounding highlands, that at first glance the valley appears to be but a continuation of the Great Plains which stretch eastward for hundreds of miles. Near the bordering mountains, a gently rolling plain slopes at a low angle toward the center of the valley. Arroyos have cut deeply into this plain, and the steep sided gullies constitute an important feature of the marginal area. The arroyos are roughly parallel with one another. In their middle courses the arroyos are narrow and quite deeply incised into the alluvium while toward the center of the valley they become broad, flat floored valleys but retain the steep sides so characteristic of their upper courses. Excepting after heavy downpours in the mountains or when winter snow is melting, these valleys are entirely without streams.

FIGURE 2.—The Manzano Mountains from the center of the Estancia Valley. These mountains separate the valley from the Rio Grande. The vegetation in the foreground is characteristic of the valley bottom. The bushes are mainly chamisa.

The presence of abandoned shore features, such as spits, bars, and wave cut cliffs about the level floor of the valley show that the basin was occupied by one of the ephemeral lakes so common during the Pleistocene period. In the center of the valley, hills from 100 to 200 feet high surround alkali flats and salt lakes. These hills are in reality dunes of clay which the winds have blown up from the valley floor. The depressions are now occupied by the alkali flats and salt lakes. These hills are a prominent feature of the landscape and are particularly noticeable since they occur on an otherwise flat plain.

CLIMATE

The climate of the Estancia Valley is classed as semi-arid, and in many respects is similar to that of the Great Plains. Rainfall is deficient in quantity and irregular in distribution, varying

from month to month and from year to year. Summers are hot and winters relatively cold; during all seasons there is a great diurnal range of temperature, but because of the dry air these extremes are made less noticeable.

Spring comes slowly to this region. Because of the dryness of the atmosphere, and the elevation, nights remain cold long after daytime temperatures have risen appreciably. There is danger of killing frosts until the middle of May. Precipitation is scanty during this season consequently there is little change from the brown of winter to the fresh green of spring vegetation save in the mountains, where the pale foliage of the aspens contrasts with the somber hue of the pines. The herbage becomes a little less gray, and grass shows signs of awakening life, but the brilliant green of more humid regions is lacking.

In summer, the earth is strongly heated by the midday sun, but so great is the radiation from its surface in this high, dry valley, that hot days are followed by cool nights which in the early part of the season have a frosty tang of winter. Killing frosts have been known to occur during every month of the year excepting June, July, and August. Mid-day temperatures of 90 degrees and above are common, but because of prevailing dryness the heat is not oppressive, and sunstroke is unknown. Even in midsummer, the heat of the day is rapidly dissipated after sundown and nights continue to be cool.

During July and August, thunderstorms are of frequent occurrence. Almost every day masses of clouds collect, there is thunder and lightning, and usually a little rain falls. Such storms are of short duration; the clouds are soon dissipated, the sky clears rapidly, and the sun shines brilliantly as before. A large proportion of the annual rainfall is accounted for by these thunderstorms, few of which are very severe. It is not unknown for a large part of the total rainfall in a summer month to be furnished by one or two exceptionally severe thunderstorms.

Despite the fact that summer is the rainy season, there is little of greenness in the landscape excepting for the evergreens. Most of the valley is a yellowish brown plain where heat waves shimmer in the sun. The bean fields, located in the midst of pinon and cedar, contribute to make the valley appear less sun scorched, but throughout the year the dominant color note is some shade of brown or gray.

The declining sun loses some of its brilliance in autumn, but days continue to be bright and warm. It is in the cooler nights, bearing a hint of

FIGURE 3.—The 500-foot escarpment of Mesa Jumanes forms the southern boundary to the Estancia Valley.

FIGURE 4.—Salt lake and alkali flats near the hydrographic center of the Estancia Valley. In the background is a clay dune. The white deposit over all is not snow, but alkali.

frost, that the change of seasons is most noticeable. The thunder showers of summer become less and less frequent, and for days on end, the sun shines from a cloudless sky. The ground becomes parched and dry , and all vegetation loses its last traces of greenness.

Winter is a season of clear, crisp, bright days, and cold, frosty nights. There is very little cloud cover and the sun shines almost as brilliantly as in summer. Daytime temperatures are moderate although in sheltered locations the sun's heat is strongly felt. Nightfall brings a sharp drop in temperatures, and zero weather is not unknown. Heavy storms with deep snows are rare, and only in the highlands do drifts remain long on the ground. Generally, snowstorms consist of flurries of small crystals which the wind carries into furrows, ditches, and other sheltered places. For the most part, the valley is bare and brown, with patches of snow in sheltered arroyos, under pinon and cedar trees, or in the shade of bunches of grass or brush. These light snows are important to the agriculture of the valley, for if their moisture can be conserved, crops have a better opportunity for early growth.

Strong winds which raise clouds of dust make late winter and early spring the most unpleasant time of the whole year. These drying winds are annoying, but on the whole, do very little damage. In only a few places in the valley is wind erosion sufficiently great to become a problem.

NATURAL VEGETATION

The central part of the valley is covered with short grasses, of which black grama (*Bouteloua eriopoda*), and blue grama (*B. gracilis*), are the most prominent. Large areas are covered by sage (*Artemisa*) and chamisa (*Atriplex canescens*), interspersed with yucca (*Yucca glauca*) and cactus (*Opuntia sp.*). Near the alkali basins sacaton or salt grass (*Sporabolus airoides*), is the common vegetation. Excepting where they have been planted and carefully irrigated, trees are entirely lacking in all of the area once covered by the lake.

Vegetation grows much more luxuriantly on the alluvial slopes bordering the western mountains. Here there are open forests of pinon (*Pinus edulis*), and juniper (*Juniperus*), between which stands are open spaces covered with a thick carpet of the grama grasses. On these slopes the entrana cactus (*Opuntia arborescens*) grows to a large size, and the common or prickly pear cactus is almost lacking.

On the mountain slopes are thickets of scrub oak (*Quercus arizonica*), and above these, forests of yellow pine (*Pinus ponderosa*), and aspen (*Populus tremuloides aurea*).

SOILS

As would be expected in a semi-arid climate, the soils of the Estancia Valley are pedocals. They are not uniform throughout the valley as there is a gradual transition between the soils of the moister upland areas and those of the drier valley bottom. Along the edges of the highlands lies a belt of reddish brown, sandy clay loam which contains no thick zone of carbonate accumulation. This soil is friable and easily cultivated. In the valley bottom, the soil is a heavy, indurated clay loam. A short distance below the surface, carbonate accumulation is strongly marked, and in places a thick layer of "caliche" is found. The waters brought to the surface by capillarity carry large amounts of minerals, so that these soils are generally quite strongly alkaline and are unsuited for cultivation.

FIGURE 5.—Typical vegetation of the region at the foot of the Manzano Mountains where most of the beans are grown. In the background is a thicket of pinon and cedar, in the middle distance, entrana cactus. In the foreground there is grama grass.

HISTORICAL DEVELOPMENT

Until the early part of the present century the Estancia Valley was an isolated region supporting a sparse population engaged in raising sheep and cattle. Most of these people lived on scattered ranches in the valley. The land was in open range, and the grass and herbage supported thousands of head of stock. The day of the open range has passed and the land is divided into smaller ranches, but in the eastern and central portions of the valley the livestock industry still survives.

Formerly, the greatest concentration of population was in the foothill villages of Chilili, Tajique, Torreon, and Manzano, located on the eastern flank of the Manzano Mountains. Here for centuries a Spanish population had lived a peaceful, pastoral existence, almost unaffected by changes in the world without. A few tiny mountain streams furnished enough water to irrigate the small fields upon which they raised most of their food: their sheep ranged the mountains in summer, and were pastured in the low country in winter. Building materials, stone and adobe, were near at hand; the forests supplied fuel; all of the simple needs of these people were furnished by the land, so there was little necessity for close contact with the outside world.

This primitive mode of life has continued almost until the present time, for these villages are still off the main arteries of travel. Life has been altered, but not completely changed by

modern progress. The picturesque villages, with their stone and adobe buildings, laid out in irregular, winding streets are a picture out of the past and contrast strongly with the newer towns on the railroads.

The Belen cutoff of The Atchison Topeka and Santa Fe Railroad, which cuts across the southern end of the valley, and The New Mexico Central Railroad, which traversed it from south to north, brought great changes. The open range disappeared and ranches were fenced; land was opened for homesteading, and settlers came in to clear the rolling lands near the mountains. Farmers began to displace the sheepmen and cattlemen everywhere excepting in the dryer parts of the valley where agriculture was unprofitable. The modern towns of Estancia, Willard, Moriarty, and Mountainair grew up along the railroads to supply the new population with goods.

It is only for the past twenty years that beans have been an important crop. Before that time Irish potatoes were extensively cultivated but were finally destroyed by disease. Even today potatoes cannot be grown successfully, for they produce only tiny tubers and luxuriant tops. Because of the distance from large centers of population, and rather severe climatic conditions, most cash crops were not adapted to the region. Mixed farming could not be successful because of the combination of aridity and short growing season. There was need for a crop which could grow under rather unfavorable conditions; which would have a ready sale outside the district, and command a sufficiently high price to pay costs of transportation.

Pinto beans seemed to fulfill most of these requirements. They were well adapted to the soil and climate, and there was a small market for them in

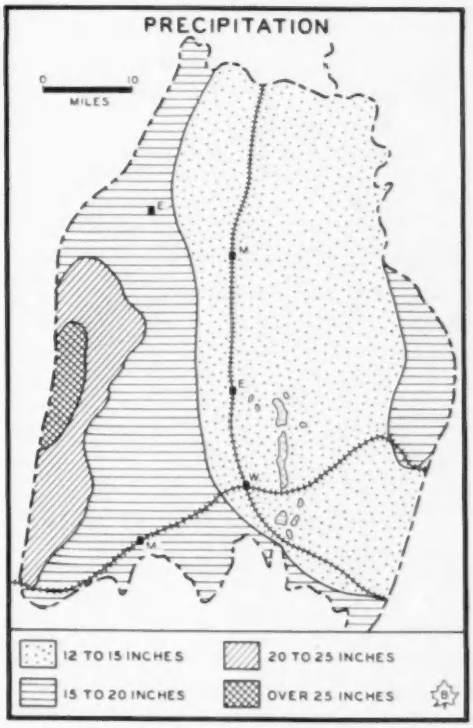

FIGURE 6.—A comparison with Figure 7 shows the close correlation between the 15-inch isohyet and the dryer limit of bean production.

New Mexico, but not large enough to take all of the production. A ready market for all that could be grown was found in the lower Rio Grande Valley and the cotton districts of Texas, and so the problem of distribution was solved.

The initial yield of beans was so good that within a few years they became the most important crop in the valley. The production was not large every year, but there was always a market for whatever was raised, and the possibility of "making a killing," if conditions were favorable, the crop large, and the price high. The result has been that almost everywhere that beans can be grown, they have become the most important crop; in many places, the only one.

LOCATION AND SIZE OF UNITS

The principal agricultural section of the valley is located at the base of the Manzano Mountains, and extends from Mesa Jumanes on the south to the Ortiz Mountains on the north. From a narrow belt west of the town of Estancia, it widens out southward in the vicinity of Mountainair, and northward near the town of Edgewood. This area, which includes some of the lower foothills of the mountains, lies at an elevation of from 1,900 to 2,100 meters. It is better adapted for bean culture than the center of the valley, for not only is the amount of precipitation greater, but also, here snow lies longer on the ground, melts slower, and hence, is of greater benefit. In addition, the sandy loams of the uplands are superior to the compact, alkaline, clay soils of the valley bottom.

On the east side of the valley, near Pedernal, there is a small section devoted to agriculture. Soils and climate are similar to those at the same elevation at the foot of the Manzanos. Generally speaking however, most of the good agricultural land lies west of the railroad.

Farms in this district contain from 100 to 400 acres. In the foothills, holdings are small and only a few acres are devoted to beans which are a subsistence crop among the Spanish-American farmers. Elsewhere, the number of acres in beans is larger although it is difficult for one man to cultivate more than 200 acres.

Most of the small farms in the foothill region are operated by owners, and there is very little tenancy among these people. On farms devoted exclusively to beans the percentage of tenants may be as high as 50 per cent. Land is leased on a crop rental basis, the tenant paying 25 per cent of the crop to the owner, and retaining 75 per cent for himself. All of the implements necessary for operation are generally supplied by the operator.

LIVING CONDITIONS

Farmsteads generally consist of three or four unpainted buildings crowded close together near the road. There is usually a windmill, and a few straggly cottonwood trees about it. Barns are particularly small and poorly constructed, being only large enough to keep the family cow, in the rare instances when there is one. Farm machinery is kept in a lean-to near by or else out in the open exposed to the weather. Dwelling houses appear to be in as poor state of repair as the outbuildings. Some of the houses are finished inside, and are clapboarded

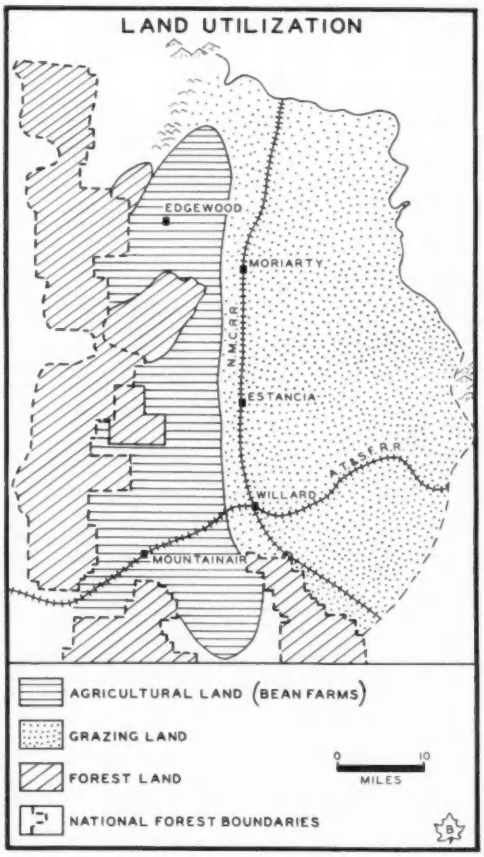

FIGURE 7.—Land utilization in the Estancia Valley.

without, while others are little better than shelters consisting of planks nailed vertically to frames, and are entirely unfinished. All of the houses are small and entirely without modern conveniences such as toilet facilities, electric lights, etc. The gray of the weathered boards gives the farmsteads an air of desolation and poverty.

Land values run from $8.00 to $15.00 per acre, the best farms being those on which water is readily obtained. In some places wells are 500 feet deep and the quantity of water is only sufficient for domestic needs. In other places water is found at depths of from 100 to 300 feet, and in fairly large quantity.

As a general rule, farms are occupied throughout the year, but not infrequently both owners and tenants spend only the busy season on the land, and live in town for the rest of the year. There is a small group of what might be termed "suitcase farmers" who do not live on the land at all, but plant only when spring conditions seem to be especially favorable. Their fields frequently receive little care during the summer, and the yield is almost entirely a matter of chance. If conditions have been favorable, profits from this practice may be large; if on the other hand, there is a complete failure, the planter has lost only the cost of seed and planting.

Throughout all of the region there is little interest in growing anything but beans. There are very few vegetable gardens, even where water could easily be pumped or otherwise supplied for irrigation. Ordinary farm livestock is likewise almost entirely lacking. There are a few chickens and pigs, but most farms do not even have these. Such cows as there are supply milk solely for their owners' use, and there is only a little milk and cream shipped out. As a whole, the farmers do not supply their own needs in milk, eggs, and meat.

The bean country suffers from all of the evils of one-crop farming. Much land is used for beans which could better be devoted to pasture or to some other crop. The farmer stakes his time, money, and labor, against the hope that he can make a crop which can be sold at a price sufficiently high to allow him a profit on the venture. Most of the time, the weather is against him. Too little moisture in spring results in crop failure as the seed cannot start. Snow on hard frozen ground gives the same result. Insufficient, or poorly distributed summer rainfall results in drought which damages the vines, and a wet autumn causes mildew, in addition to making harvest difficult.

Against all of these hazards there is the possibility of making a bumper crop. With good prices, one such crop will almost wipe out the losses of previous years and pay for the effort expended. At such times, debts are paid, buildings are repaired, and new machinery and automobiles purchased. Families are supplied with some of the luxuries, and many of the necessities of life which they have been denied for years. Then the cycle starts over again, for

FIGURE 8.—A farm establishment in the Estancia Valley. The buildings are few and small. Note the absence of trees.

almost never do good harvests occur on successive years.

CULTIVATION AND YIELD

On bean farms, there is little work done for half the year; the busy season begins in May and lasts until late October or early November. The growing season is short, and beans must be planted as early as possible, but because of the danger of frost in these high altitudes, this cannot be done much before the middle of May. Even then, danger is not entirely absent, but light frosts do little damage. Should freezing be severe, fields must be replanted. For its initial growth, the seed is dependent upon the moisture stored in the ground. The source of this moisture is the snow of late winter, which upon melting, seeps into the soil and becomes available for the plants. Little rain can be expected in June, so the stored moisture must be sufficient to carry the young plants through this dry month. Sometimes crop failures follow severe winters in which there has been a heavy snow cover because the water runs off the frozen ground and never becomes available for plants.

With ample moisture, seeds sprout, and plants grow rapidly, soon reaching their maximum size of from 15 to 18 inches. Rapid growth is essential during the short summer, and the hot sun greatly aids in this rapid development. During July and August, rainfall is sufficient for growth, but unfortunately, much of this precipitation comes in a few heavy downpours which run off the surface. The zone of carbonate accumulation effectively stops moisture from penetrating deeply and rapidly into the soil. As a result, there may be periods of drought during the summer, even when rainfall has been adequate.

The vines must be cultivated several times during the summer, and if there are indications of a large crop, the plants will also be hoed. This latter is the most laborious work of the whole year, and at this time there is need for outside help. Beans are usually ready for cutting sometime between the first and the tenth of September. The vines are cut in much the same manner as hay, and are placed in small stacks, where they remain at least ten days in order that all may become equally dry, since at the time of cutting some of the beans are riper than others.

Bean threshing is similar to that of wheat. Bundle wagons are driven into the field and return piled high with stacks of vines. These are pitched into the machine; hulled beans come

FIGURE 9.—Almost all of the land from the foreground to the foothills of the distant mountains has been planted in beans.

out and are immediately sacked, while the straw and refuse are blown into large piles. The straw and hulls are sometimes used as feed for cows.

Sacked beans are taken to the nearest town where they are sold to mercantile establishments or bean buyers who maintain cleaning plants for the separation of the beans from pebbles and chaff. Many plants also do custom cleaning for those growers who wish to hold their crop for an expected rise in prices and for independent buyers who lack the necessary facilities for cleaning. Most of the crop moves out of the district by rail to the cotton districts or to the lower Rio Grande Valley of Texas.

Yields vary greatly, ranging from 30 pounds per acre in poor years to as much as 800 pounds per acre when conditions have been ideal. Not only does the yield vary greatly from year to year, but it also varies greatly from place to place during the same year. Because of micro-climatic variations, one part of the valley may have an excellent crop, while a few miles away, fields will be barren. There are a few farms, favorably located, usually near the mountains, where good yields may be expected year after year, but in most places there is great variation.

The amount of moisture available is so low that any slight decrease is reflected in lower yields. Decrease in precipitation is particularly harmful if it occurs in late winter or early spring, for it is upon this moisture that plants depend for their starting growth. At best, this stored moisture is barely sufficient to meet the needs of growing plants, so dry winters indicate almost certain crop failure.

Because slight deviations from average moisture conditions have such far reaching effects upon yield, there can scarcely be said to be such a thing as a normal crop. Over a ten year period, the average yield has been slightly less than 300 pounds per acre. A good yield is 450 pounds per acre, while 500 pounds of beans per acre is cause for rejoicing.

FIGURE 10.—Plants for cleaning beans at Mountainair, New Mexico.

In order to pay expenses of operation, on the average sized farm, the yield must be at least 300 pounds per acre, and the price 3½ cents per pound or better. Under these conditions it is possible for a farmer to make a living for himself and family, but no more. This minimum figure is slightly above the average production for the past ten years, so it is apparent that bean growers do well if they make a bare living.

Bumper crops come rarely, usually at intervals of from five to eight years; there having been only four exceptionally good years during the twenty years in which beans have been planted. There are not enough good years to enable farmers to accumulate the surplus necessary to carry them over the inevitable years of failure, or to make essential improvements on property. As a result, farm buildings are chronically in a state of poor repair, and help to convey the impression of prevailing poverty.

Most of the time, after disposing of his crop and paying debts incurred beforehand, the farmer has no more than enough money to carry him through the winter. When spring comes, it is necessary for him to borrow in order to put in a crop and pay running expenses through the summer. He operates on credit at least a part of every year. Merchants and bean buyers have long considered the extension of credit as an integral part of their business. When crops fail, loans must be extended, and additional credit given to enable the farmer to carry on until conditions improve. For the past few years the federal government has been assisting bean growers by extending seed loans.

FIGURE 11.—Interior of a cleaning plant, showing sacks of beans piled and awaiting shipment.

CONCLUSIONS

The system of farming, in which all efforts are concentrated on the production of one cash crop, is undoubtedly one of the principal causes of the generally unfavorable economic conditions which prevail in the Estancia Valley. Here, as in other one crop regions, efforts to change the situation have not been entirely successful. It is easier to cultivate one crop than several; there is always a demand for beans and no marketing problem as they can be sold at the nearest town or village; the period of labor is not extended throughout the year, and it is possible for the farmer to live in town a part of each year. The disadvantages of the system are readily apparent, failure of the cash crop, or low prices means poverty for the farmer. Without secondary and subsistence crops, there is no possibility of living off the land, and little chance that the condition of the one crop farmer will materially improve.

The remedy seems to lie in greater diversification wherever possible, with emphasis on self sufficient agriculture. It is difficult to find commercial crops to take the place of beans, which will thrive under the rather severe climatic conditions. The growing season is too short, and rainfall too scanty for many agricultural products, but a number of things might be raised for home consumption. Where water for irrigation is available, vegetables can be raised. The shipment during the past summer of 22 carloads from an irrigated farm, shows what might be done in this direction.

A program of self sufficient agriculture is not well adapted to those areas where water is difficult to obtain. In certain places it is hard to get enough potable water for human consumption and uses, and the problem of supplying enough for irrigation and for livestock would be too great to be attempted. In such areas, beans will probably continue to be the major crop.

It is not suggested that the Estancia Valley will ever become a highly prosperous mixed farming region, or that its output of dairy products will be very great. The economic condition of the region can be improved, however, by raising more foodstuffs for home consumption, making the farmers less dependent upon the pinto bean.

SEQUENT OCCUPANCE OF A BOSTON SUBURBAN COMMUNITY

Edward Ackerman

IMMEDIATELY outside the Boston Basin lies a semi-circular zone of scattered suburban towns. The small centers in this zone, although physically detached from Boston, are intimately associated with the social and economic life of the city. Supported now by commuters and truck gardeners, these towns developed around old farming communities, which, in their turn, were located by soil pockets of moderate to exceptional fertility. They are interesting as present-day adjustments to a New England metropolitan area, and their varied history makes them excellent subjects for a study in sequent occupance. One of the most typical of these towns is Concord, about twelve miles from the edge of metropolitan Boston. Its tributary area is notable not only for its size and fertility but also for the length of time that people have occupied it. Even in Indian days the soil here was tilled, and its utilization has continued without interruption to the present day. However, the character of the settlement on this land has not remained always the same, for successive communities have been subjected to different and changing geographic backgrounds.

On cultural and environmental bases one may establish five periods of occupance in the Concord area: the aboriginal Indian; the colonial period of subsistence farming (circa 1635–1775); the dairying and manufacturing periods (1775–1830); the period of rural depopulation (1830–1880); and the modern era of intensive truck gardening and residential property expansion.

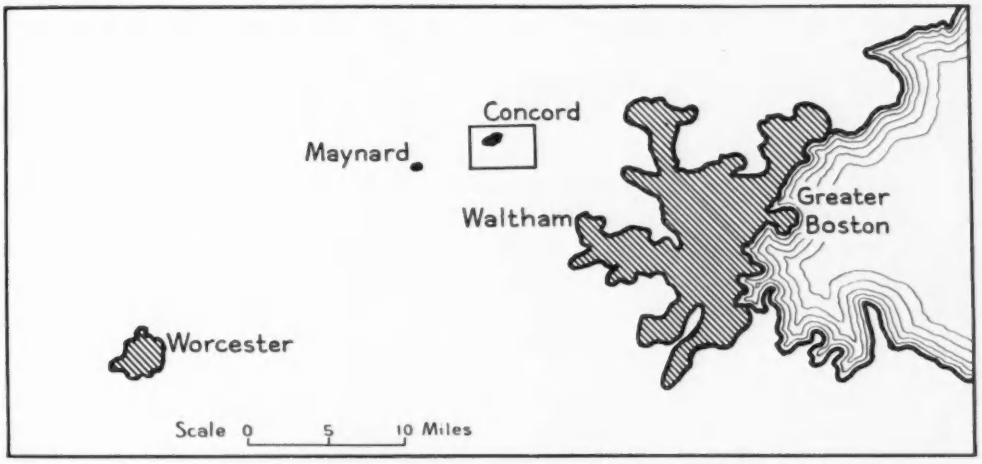

FIGURE 1.—The Concord area in relation to Greater Boston.

Behind each community, Indian, colonial, or modern, has lain a definite set of environmental factors—some, like climate or soil, unchanging, and others, such as relation to centers of population, or technical knowledge, never alike.

FIGURE 2.—Generalized soils types of the Concord area. Dashed lines indicate present-day roads, and limits of the thickly-settled parts of the town.

When in 1635 the Massachusetts Bay colonists first turned inland, they took up farms on the loessial terrace soils of this Concord district. The first settlers to arrive in the district found Indians already farming there. The Indians in their turn, according to the legend, had found this "fertile spot" treeless and free of stones many years before, and had since cultivated it in their customary manner; a circumstance rare in New England. The origin of soil cover free from boulders presents a physiographic problem which has received some attention. See H. T. U. Smith and H. J. Fraser, "Loess in the vicinity of Boston, Mass.," *Amer. Jour. Sci.*, vol. XXX, July 1935, pp. 16–32. Although it is not proved that the stone-free soils of Concord and similar areas are composed of loess, these soils very closely resemble loessial deposits.

During the period of Indian occupation areas grown to brush were burned over each spring, and beans, maize, and squash were planted and harvested on the plots in rotation. Ashes from the brush-burning and alewives from the nearby streams formed their fertilizers. But the Indians lacked implements and technique, so that even with fertilizer yields were not large, and the tilled area was small. Plots in the vicinity of their village on Lee's Hill, and sections of the easily cultivated Great Fields were all that they tended. They left the heavy meadow soils untouched, and they never set foot on the stony uplands except to hunt. Undoubtedly they relied on fish and game, on nuts and wild grapes as much as on their own sown crops. However, as Indians go, they were prosperous and peaceable—until the English colonists arrived. The Bureau of Chemistry and Soils identified eight different soil types for this area in its "Soil Survey of Middlesex County, Mass." (Latimer, W. J., and M. O. Lanphear, Bureau of Chemistry and Soils Bulletin No. 26, Washington, 1924.) The distinctions, however, are often so minute that they are of little use in considering crop distribution. Three types significant to land use: the sandy upland soils which occupy the hill tops and upper slopes; the light sandy terrace soils of the intermediate slopes and terraces (the loess-like deposits); and the meadow soils of high humus content found near the stream bottoms. See Figure 2.

The first colonists were subsistence farmers and not primarily hunters, as

FIGURE 3.—Meadow and woodland along the Concord River, northeast of the town center. A surviving bit of the late colonial and nineteenth century types of occupance.

the Indians were. They continued with crops that their predecessors had raised, but cultivated them more intensively, and soon imported other plants. The early colonials, like the Indians, took advantage of the spring runs of shad and alewives which came up the Concord River, and also hunted the game of the nearby forest, but they depended on the soil. Although the colonists took over the same lands, and for a while planted the same crops, a new period began with their arrival. Each succeeding year found the extractive resources of the area more restricted and farming more dominant, until finally Concord community was entirely agricultural.

At the end of the first three decades of colonial Concord's existence much woodland still remained in the town, but soon afterward rapid expansion and extension commenced. Trees were cut down, at first for firewood and home-building purposes, but later to be made into lumber for Boston ships and houses. Land was cleared apace, and it is reasonable to assume that by 1750 the area was cleared to the degree that a Concord historian found it in 1830, when he speaks of "extensive meadows, lying adjacent to upland plains," and of "large quantities of open land, bearing resemblance to the Western Prairies." His map (Figure 4) shows the great extent of the clearing and cultivation, an impressive contrast when one compares it with the amount of forest shown on the present-day land utilization survey (Figure 7).

Not only were the upland soils cultivated in the subsistence farming period, as they are not today, but they were considered the best agricultural land. The light sandy loessial soil which was favored by the Indians, and which is now intensively farmed in all parts of the region, was then regarded as poor because its excellent drainage made it susceptible to summer drought.

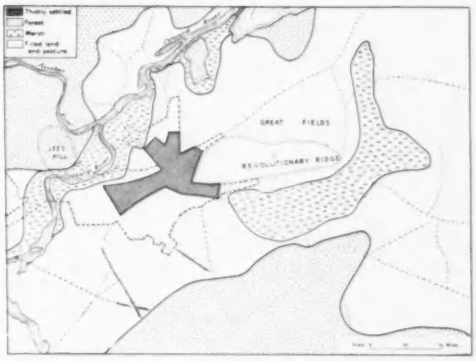

FIGURE 4.—The Concord area one hundred years ago. Taken from Lemuel Shattuck, "A History of the Town of Concord," surveyed by John Hales, Boston, 1830. Dashed lines indicate present-day roads and limits of thickly-settled area.

Otherwise there was little correspondence between soil and cultivation and only a rough adjustment to climatic conditions during the eighteenth century. Muck soils in the meadows at first were left in grass because no plow could be found that would turn the sod, and later because dairying grew to be profitable. Aside from this exception anything was planted anywhere.

Besides the Indian crops the other possible cereals were soon planted, other vegtables, apples, and flax were introduced. Wheat, oats, barley, and rye were all grown. Wheat is the notable item, since its production is particularly unsuited to the New England climate where rains are almost certain to greet the harvest. However, there was no cheaper external source of supply, so it was planted. Carrots, parsnips, peas, turnips, cabbages, and onions are early mentioned. Cattle and sheep grazed on the meadows, pigs fed on the acorns and other nuts of the woods, and poultry were kept by every housewife. The farm was an almost complete economic unit, its family being producer as well as consumer of all but a few of the wares that the people needed.

This practice of self-sufficiency some-

times led the colonial into flagrant, and amusing, disregard of the environment with which he struggled. Such was the case when someone concluded that silkworms were suited to the neighborhood. His conviction was so strong that he imported a number of worms, but he soon found that neither the traditional ingenuity nor the perseverance of the Yankee farmer could make the mulberry or the silkworm itself live through a New England winter. Silk, moreover, was not a necessity—and a New England subsistence farmer had to concentrate on necessities.

FIGURE 5.—Stone wall of an abandoned farm. The year when cultivation was abandoned is not recorded, but may be approximated from the size of the trees on the plot. They are about sixty years old.

In the third period of occupance, which started about 1775, Concord farmers began to specialize in dairying. The development of a nearby market in Boston encouraged concentration on a few products, and occasioned the abandonment of the old subsistence–general-farming scheme. One notes with interest that tillage land in the town of Concord decreased between 1781 and 1830—and that "mowing, meadow, and pasture lands" showed a great increase.

	1781	*1830*
Mowing, Meadow, and Pasture	5941 Acres	7449 Acres
Tilled	1198 "	1098 "

Growing grass and hay was profitable, when they could be disposed of as dairy products, a fact well known today in rural New England. Furthermore, with an improved road, from Concord to Boston and return was only a day's wagon haul. Hence when Boston was large enough, and an increased demand for butter and cheese arose, Concord commenced to produce and export to the city. Concord's relation to Boston in those days was not unlike that of the present Vermont and northern New York dairying districts to the cities they serve. The growth of a center of population changed Concord's geographical background and brought it out of the economic isolation in which it had reposed. It continued henceforth as a dependency of Boston, and was no longer a separate economic unit.

Not content with its natural function of farming town, Concord in Revolutionary days tried its hand at manufacturing. By the early 1800's it had become a small factory center. In this development it was only in step with numbers of other American communities of the time. A notable expansion

of local industries took place on the basis of a sudden new American demand. English manufacturers had hitherto supplied this market, but they naturally were cut off during the Revolutionary War, and small local plants manned by labor from the nearby farms sprang up to take advantage of the situation.

In Concord, as in the other communities, primitive household manufacturing had been carried on ever since the first settlement, and bog iron had been worked by the local smiths, but only under the stimulation of the greater demand of Revolutionary days did definite manufacturing units grow up. Manufacturing persisted, by sheer inertia, we may assume, for several decades. Besides the inevitable sawmill and grist mill, Concord had in 1830 a sizable cotton mill, an iron works, a lead mill, and a bindery. Among the articles made in other workshops were shoes, clocks, hats, guns, lead pencils, barrels, brick, and furniture. The population of the town grew, and inhabitants of Concord in this period could say, in gazing on their prosperous industries, "Although Concord possesses few of those advantages of water power which favor rapid growth, her manufacturing promises to be a great source of wealth in the future." Had these men been perceiving geographers they would have recognized that the very lack of water power which they mentioned to point their optimism ought to have occasioned pessimism. Not one of the more important factory enterprises of Concord Center lived beyond 1850 in competition with plants located more favorably for power and raw materials. The wartime stimulus to enterprise was for some years mistaken as a permanent encouragement, but as profits faded, so did illusions.

While manufacturing plants were moving to better locations, farmers were hearing of greener fields in Ohio. Like many New England towns, Concord therefore experienced a period of depopulation. The town lost about fifteen per cent of its inhabitants between 1830 and 1850 (population of Concord town in 1830 was 2,017; in 1850 it was 1,778 people), and farms were given up sporadically until 1870.

There can be no doubt that many farms were abandoned in the district during the period of emigration. Tho-

FIGURE 6.—Typical occupance of the asparagus era. Asparagus in the foreground, orchard on the intermediate slope, and woodland beyond.

reau, in his "Walden" (Walden Pond, in Concord town) speaks of the ancient apple trees, the covered foundations, and of the wild lilacs: "Still grows the vivacious lilac a generation after the door and lintel and the sill are gone . . . now standing by wallsides in retired pastures, and giving place to new-rising forests." Few such traces of past settlement remain today, but occasionally the remnants of a stone wall running through a thick wood show where farms once were (Figure 5). Revolutionary Ridge—once farmed—is now almost entirely covered with fair-sized trees, and so is almost every plot

classified on the soils map as having stony upland soils. All the poor soils areas of the town were abandoned within a few years in an exodus to the West and to the growing New England manufacturing towns.

On the land that remained in cultivation farming continued during the period of depopulation in the manner of the manufacturing period. Dairy farming was the mainstay, holding a steadily improving market in Boston. General farming ceased altogether because the profit-lure of specialization either at home or in the West could not, and needed not, be resisted. In the early seventies, however, truck farming was started, and after 1875 it became certain that dairying in its turn would be displaced and a fourth period of occupance commence. There is no precise record of the beginning of asparagus cultivation in Concord. Old residents say it was commenced in the 1870's, a statement corroborated by the fact that many Indian relics were discovered in the Great Fields, a light sandy soil area, in that period. It is reasonable to assume that the relics were turned up when cultivators were preparing beds for asparagus, which required deeper plowing than previous crops. Grindall Reynolds, a local minister, in his history of Concord, states that the town produced more asparagus than any other community in the state in 1875. ("Concord" in "History of Middlesex County, Mass.," by S. A. Drake, Boston, 1880.) The advent of truck farming was coincident with a still further expanding market in Boston, and with the discovery that the light sandy soil in the

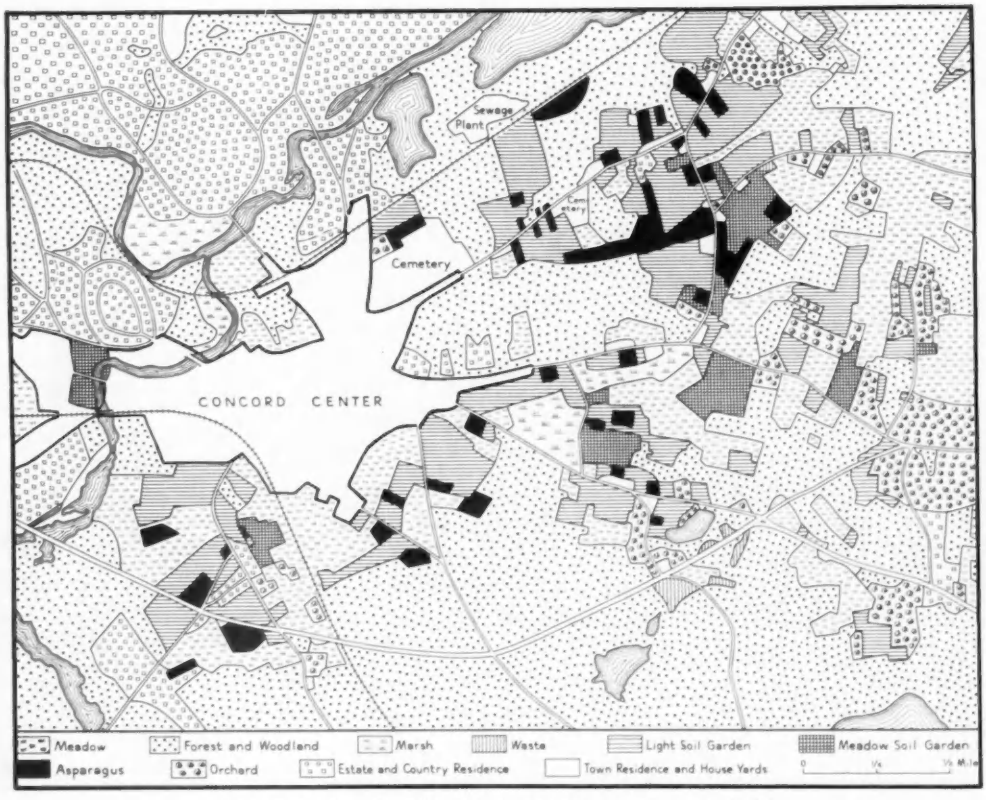

FIGURE 7.—Land utilization in the Concord area in 1939.

area was suited to asparagus growing. Asparagus soon covered the major portion of the light sandy areas. Dairying was left to the wet meadows, because the newly-discovered crop was much more profitable. Concord had moved one ring closer to metropolitan Boston, and become then a part of her suburban complex. This fact was further emphasized by Concord Center's debut as a commuting residential center. Having been on a main rail line since 1844, Concord was at this time more conveniently reached from the center of Boston than many towns within the Boston Basin. Moreover, its historical and literary landmarks, the charming old houses, and low taxes appealed to people who then were becoming uncomfortable under the foreign influx into residential areas in Boston. But even if Concord had remained nothing more than a truck-gardening spot, it would still have been more closely tied to Boston than it was as a dairy center.

The light, friable terrace soil is ideal for asparagus cultivation for several reasons. It drains well, and warms up early under the spring sun, hence gives the shoots an early start. Its friability permits the sprouts to push through without difficulty or deformity, and makes cutting (the shoots must always be cut underground) and cultivation easy.

FIGURE 8.—Light soil garden area in the Great Fields. Orchard on the stonier slopes, and wooded Revolutionary Ridge in the background.

FIGURE 9.—A well on a Mill Creek lowland farm. The pipes form part of an overhead irrigation system for a celery garden.

In addition the disadvantage that this soil had in colonial times meant nothing to the asparagus grower. An extended July to September drought was more or less serious to the colonial farmer, and embarrassing to the dairy farmer who followed him. But the asparagus cutting season extended only from early May to the first of July, a period when there is always enough rain, and after that the gardener cared little whether rain came or not. It was thus an excellent adaptation. A longer period of cutting reduces the reserve of the root, and much diminishes the yield of the following year.

Under the stimulus of high profits, asparagus spread to every practicable corner of the gardening area. A land utilization map of 1905 or 1910, according to old farmers, would have shown the asparagus plots almost coincident with the light soils area. It was so important an area of production that an asparagus Experiment Station was established and maintained by the United States Department of Agriculture. New, better bearing, disease resisting varieties were developed, and

classified on the soils map as having stony upland soils. All the poor soils areas of the town were abandoned within a few years in an exodus to the West and to the growing New England manufacturing towns.

On the land that remained in cultivation farming continued during the period of depopulation in the manner of the manufacturing period. Dairy farming was the mainstay, holding a steadily improving market in Boston. General farming ceased altogether because the profit-lure of specialization either at home or in the West could not, and needed not, be resisted. In the early seventies, however, truck farming was started, and after 1875 it became certain that dairying in its turn would be displaced and a fourth period of occupance commence. There is no precise record of the beginning of asparagus cultivation in Concord. Old residents say it was commenced in the 1870's, a statement corroborated by the fact that many Indian relics were discovered in the Great Fields, a light sandy soil area, in that period. It is reasonable to assume that the relics were turned up when cultivators were preparing beds for asparagus, which required deeper plowing than previous crops. Grindall Reynolds, a local minister, in his history of Concord, states that the town produced more asparagus than any other community in the state in 1875. ("Concord" in "History of Middlesex County, Mass.," by S. A. Drake, Boston, 1880.) The advent of truck farming was coincident with a still further expanding market in Boston, and with the discovery that the light sandy soil in the

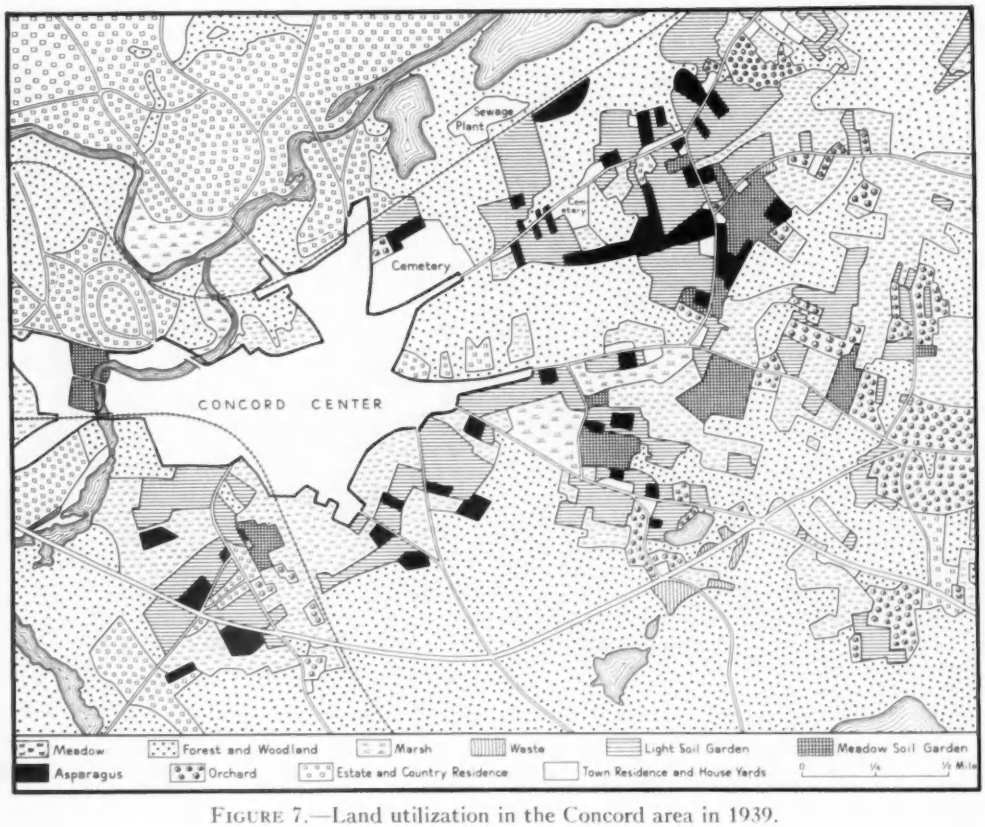

FIGURE 7.—Land utilization in the Concord area in 1939.

area was suited to asparagus growing. Asparagus soon covered the major portion of the light sandy areas. Dairying was left to the wet meadows, because the newly-discovered crop was much more profitable. Concord had moved one ring closer to metropolitan Boston, and become then a part of her suburban complex. This fact was further emphasized by Concord Center's debut as a commuting residential center. Having been on a main rail line since 1844, Concord was at this time more conveniently reached from the center of Boston than many towns within the Boston Basin. Moreover, its historical and literary landmarks, the charming old houses, and low taxes appealed to people who then were becoming uncomfortable under the foreign influx into residential areas in Boston. But even if Concord had remained nothing more than a truck-gardening spot, it would still have been more closely tied to Boston than it was as a dairy center.

The light, friable terrace soil is ideal for asparagus cultivation for several reasons. It drains well, and warms up early under the spring sun, hence gives the shoots an early start. Its friability permits the sprouts to push through without difficulty or deformity, and makes cutting (the shoots must always be cut underground) and cultivation easy.

FIGURE 8.—Light soil garden area in the Great Fields. Orchard on the stonier slopes, and wooded Revolutionary Ridge in the background.

FIGURE 9.—A well on a Mill Creek lowland farm. The pipes form part of an overhead irrigation system for a celery garden.

In addition the disadvantage that this soil had in colonial times meant nothing to the asparagus grower. An extended July to September drought was more or less serious to the colonial farmer, and embarrassing to the dairy farmer who followed him. But the asparagus cutting season extended only from early May to the first of July, a period when there is always enough rain, and after that the gardener cared little whether rain came or not. It was thus an excellent adaptation. A longer period of cutting reduces the reserve of the root, and much diminishes the yield of the following year.

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the prosperity of the gardeners increased. Newcomers who no longer found light sandy soils obtainable trucked sand from the morainal uplands onto the heavier bottom lands, temporarily improved the tilth of those soils, and planted asparagus there.

The only rivals that asparagus had in the Concord gardener's favor during its day were strawberries and apples, but they were really supplementary rather than competitive. A few orchards were to be found on the more or less stony slopes lying between the forested upland and asparagus lowland, and the acid tolerant strawberry was planted on the bottom soils. Poultry were kept, but not yet as much of a business, and except for draft horses, and a few cows there were no farm animals. An extreme specialization was dominant.

All went well until the spring about fifteen years ago, when California asparagus appeared on the Boston markets in small lots. Because the supply was small and the prices high these first shipments were not in themselves serious invasions for the Concord growers, but they were significant as an advanced guard. A few years afterward California asparagus each spring satiated Boston appetites for that vegetable long before Concord's appeared. Concord asparagus, although early from the standpoint of local production, is really first marketed late. (May 5 is the average date of first cutting.) Thus when the first delicate native shoots were ready for sale, California's continued shipments contributed to a market glut. Concord growers—accustomed to eight dollars and ten dollars a crate once, seldom received over two dollars—barely covering the costs of production.

FIGURE 10.—Celery bed in the Mill Creek lowland. Workers are boarding up the plants to bleach the stalks. This operation is one of the many required in a meticulous care for the beds between planting and maturity.

After 1925 asparagus plots became fewer each year. Some remain in the area, as the land utilization map shows, but asparagus growing is far from being the preponderant type of gardening.

Soon following the asparagus upset another invasion took place. Trucking interests, encouraged by good roads and New England prices, brought strawberries up from the south Atlantic coast, and deprived strawberry growers of the high prices ordinarily obtained at the beginning of the native season. In previous years southern berries had appeared on local markets, but only during the off-season for native produce, and then at high prices. As soon as cheap truck transportation became available, growers of strawberries in Maryland could compete with and even undersell the local growers at the height of the local season, and especially during the financially important early weeks. To obtain a modest profit the Concord grower must sell his berries at high prices, not only because he incurs losses by diseases and insect pests every year, but also because of high local wages for pickers.

The Concord gardener therefore has less ground in strawberries than formerly. Some patches are planted each year, but they now cover less ground than the asparagus beds. Only the old

orchards of the asparagus–berry–apple combination remain in favor.

Gardening is by no means dead in Concord, and is not likely to be for some years to come. But an interesting adjustment has taken place since an improvement in transportation facilities doomed the first profitable type of garden production. Concord gardeners have turned to the growing of non-competing crops for the Boston markets—principally those which are so heavy and low-valued that they cannot stand the freight from points outside the state—such as squash, cabbage, cauliflower, and melons; root crops; and vegetables which do not keep well in transit, like sweet corn and string beans. The principal consideration is low value per unit cost of transportation, but Concord grows anything with which it can compete favorably. Coupled with the change in crops grown has been a change in methods of marketing. Formerly Concord growers carted their produce to Faneuil Hall Market, the Boston food exchange. Now, however, it is estimated that one-half of the vegetables grown are sold locally. The era of automobile transportation, although it took away the profitable berry trade, has benefited the gardener. Nearly every farm in the Concord district has its roadside stand, where many of the farm products are sold. This business has developed to such an extent in the area that Italian gardeners who have plots some two or three miles from the motor roads keep stands along the highways running into Concord. All who engage in roadside selling agree that it has enabled the smaller farms to keep in operation. Those who cultivate more than ten acres of vegetables cannot dispose of everything at the roadside, but they do not hesitate to operate a retail stand. Surpluses on many farms are reckoned in terms of what cannot be sold at the roadside, not of the Faneuil Hall demand.

FIGURE 11.—Farmhouse of the colonial era, the Meriam House at Meriam's Corner. The contrast in size and architectural beauty is very striking when one compares it with the small, nondescript houses built in the area in recent years.

Besides the remaining asparagus plots there are two types of gardens now in cultivation, the light sandy soil, and the meadow soil gardens. Two crops a year customarily are grown in the light sandy soil gardens, for which plants are often started in the hotbeds in early spring. Peas, sweet corn, and string beans are favored early crops, but some tomatoes also are set out in these gardens every year. After the beans or peas have passed their peak yield, they are plowed up, and a second vegetable crop put in. Cabbage, cauliflower, shell beans, and potatoes are common second plantings. Where corn is sown, squash, pumpkins, or melons may be planted as an intertilled crop.

Most areas of meadow soils within the area remain in marsh or meadow, but in places they support a kind of gardening peculiar to themselves. Gardens on meadow soils differ from the light soil gardens both in the practices of cultivation and in the plants grown. Three producing crops a year are characteristically raised on these plots instead of the two on the light soils. The succession may be three crops of spinach, or it may be early beets, lettuce, and finally spinach. Radishes, onions, ro-

maine, or chinese cabbage may be substituted at any point in the above rotation. Peppers are grown in the fall. Celery has enjoyed great popularity on the meadow soil garden plots for the past two or three years, and where it is planted only two crops are grown—lettuce being customarily the first one. All crops are irrigated during late July and August, and during other months if unusual drought occurs. The possibility of drawing water from inexpensively sunk wells has undoubtedly determined the kind of vegetables grown on these soils, for plants like lettuce and celery require generous amounts of water. A system of overhead pipes is usually installed, and one of the limitations of the climate thus overcome.

The formerly occupied sandy upland soils are now for the most part devoid of cultivation. Woodland of various sorts covers ninety per cent of the coarse sandy soils of the area. Nothing but a few apple and pear orchards are found on this infertile type, and they are on the slopes near the gardens. In the Concord district the orchards are not large-scale thriving enterprises, as they frequently are in other Massachusetts towns, but generally are supplementary to a small garden.

Houses and roads are typically restricted to the light sandy lowlands. With the exception of several estate residences, and of the new motor highway on the south, the uplands are now devoid of cultural features. Old roads followed the contour on the light soils as much as possible, and old houses were never built on the bottoms or meadows. Few modern houses are found on the bottoms. A farmer having a garden on a plot of these soils usually places his house and outbuildings on the nearest bit of light sandy soil.

In the colonial days large farmhouses, large barns, and large landholdings were the rule. That also held true throughout the dairy farming era, but from the beginning of truck gardening to the present a gradual change in the size of holdings and the type of buildings has taken place. A colonial farm, even in the lowlands, ran from a minimum of 60 to more than 300 acres in size, and any of the surviving colonial buildings witness the size of former houses and barns. Now the largest holding is not more than 60 acres, and many are much nearer, sometimes under ten acres. Not more than half of most truck farms is actually garden, but comprises garden, orchard, woodland, etc. Houses are little in the average farm unit, and outbuildings are small and numerous. Poultry houses, tiny storehouses, and vegetable washing places have taken the place of the old barns.

This tendency toward small holdings and unpretentious, sometimes ill-kept establishments has been emphasized greatly in recent years.

Even though his establishment is modest, and although he has adapted his cultivation to the market conditions, the Concord farmer is not without his troubles. There are many things that tend to raise expenses, and keep profits at a minimum. The truck gardener farms the best soil in the town, but even that is constantly in need of replenishment by fertilizer—and as the tendency to intensify production progresses, the need of fertilizer becomes acute. Gardeners prefer animal fertilizers where they are available, but these are becoming more scarce in the vicinity each year. Horse manure could be bought cheaply in outside towns, and a small amount in Concord. The former supply ceased with the advent of the truck, and practically none is to be found in the area, because tractors have replaced horses for farm work. The

amount of cow manure that can be supplied by the dairies in the vicinity is also far from sufficient to meet the heavy demand of the gardens. It is hauled to Concord from as much as twelve miles distant, and costs about eight dollars per cord by the time it gets there. If animal fertilizer alone is used an average garden soil demands ten to fifteen cords per acre.

Farmers are turning to the use of chemical fertilizers as a solution to this problem, but although they are originally cheaper, there is an expense of plowing and sowing rye each autumn for the addition of humus to the soil. This is somewhat counterbalanced by the fact that lime, included in chemical fertilizers, must always be added to the soil when manure is used. But in the end the cost of the chemical method is said to equal that of animal fertilizer. The replenishment of the soils is a much more real problem to the annual seed crop gardener than it was to the former asparagus farmer, whose plants did not take so much.

The labor problem is one which follows close on that of fertilizer. At planting, weeding, and harvest seasons quantities of additional help are needed in every garden. None is obtainable in Concord itself because there are no extras of the laboring class in a non-manufacturing, purely residential center of its type. Hands are brought in from manufacturing towns like Maynard, Waltham, and other places, especially from Waltham, where many men and women extras are to be found. They are paid wages of $2.25 to $2.75 a day for a poor quality of labor, according to the gardeners. Even at its best labor is expensive.

Diseases and pests occasion losses and expenses of precaution that figure on the farmer's balance sheet. The corn borer cuts down green corn production; raspberries are bothered by blight; cutworms decimate rows of garden

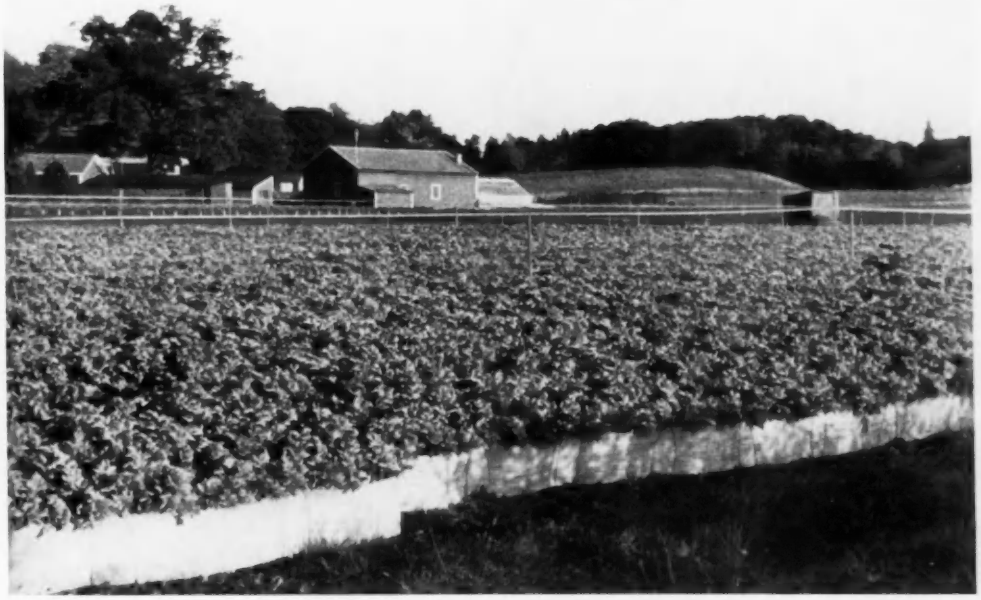

FIGURE 12.—Truck farm and typical group of modern buildings in the southern part of the mapped area. Celery bed with overhead irrigation pipes.

plants; celery is affected by blight; lettuce takes rust; apples are injured by fungi and railroad worms; and rodents gnaw the root crops. In addition there is always a possibility that an unseasonable frost may ruin all calculations. Concord lowland is rife with stories of plantings nipped in blossom (The most recent incident was a frost on June 20, 1940.), and every grower has some pest which he deems his special bête noir. Losses themselves may be insignificant, but numerous sprayings eat away profit.

In such a situation profits inevitably declined, land values dropped, rural houses fell into disrepair, and people became discouraged. As a result a new foreign group has in part taken the place of the Yankee gardeners. Italians, Swedes, and Poles are eagerly moving onto land on which the New Englander feels that he is fighting a losing game. But even with the new element, gardening is no longer the principal means of support in the community.

In fact no better indication is provided of the financial difficulties of the average gardener than the fact that he almost invariably attempts to supplement his income with an occupation other than gardening. The efforts are varied. Some keep bees, some have orchards within or outside this area, others work outside—for the town, county, or even in Boston; a few keep two or three cows. "Tourist homes" invite the visitor among Concord's sights, and small boarding kennels cater to needs of a nearby city population. The most popular supplements, however, are poultry keeping and woodcutting. If a farmer has a woodlot, his autumn and winter months are profitably spent cutting fireplace wood for the Boston trade. He may even buy the wood standing on someone else's land, cut it and sell it. Poultry raising is always a supplementary, and

FIGURE 13.—Poultry shelters in a light soil garden on the edge of the Concord area. Asparagus in the foreground, orchard and annual seed crops near pond in the middle distance.

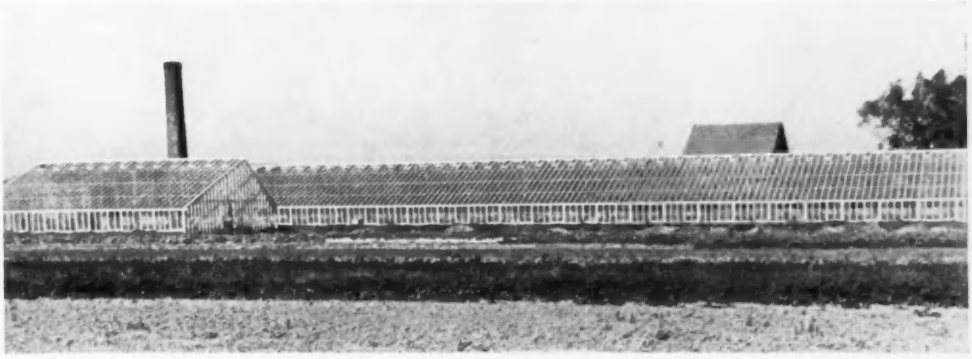

FIGURE 14.—Greenhouse in the Great Fields, the largest in the district. A supplementary undertaking of the large gardens.

not a principal activity. Chickens and turkeys do well on the light sandy soils where most of the gardens are, and there is a ready market for eggs, broilers, and turkeys on the roadside vegetable stands. Three greenhouses attached to the largest market gardens in the area are also supplementary enterprises, but they are so expensive to install that other gardeners have not been able to finance similar plants. Greenhouses are apparently profitable supplements, extending the local vegetable season about five months, and growing crops during the summer which do not mature well outside. Radishes, lettuce, and dandelions are common cold season greenhouse crops, and cucumbers are grown during the summer.

There is thus a return to diversification, but a very different one from the general farming of 150 years ago. It illustrates nicely the change in marketing conditions that has taken place. The old diversification was that of producing everything a family needed for life; now that the day of household industry is forgotten, it is to produce anything that a family can sell.

Because of expensive upkeep, and increasing outside competition one well may be pessimistic about the future of the gardens. Already the competition of distant areas with a comparative advantage has taken all the profits on Concord's *primeurs* and it has been left to eke out an existence on stock seasonal articles. Now even the latter are threatened by the development of specialized areas in the South and West. The competition of high quality frozen goods is just as serious. Concord farms may in the end be left to corn, squash, and beans—the plants that the Indians started with. The tendency for southern and western truck farms to displace northern market gardens is noticeable in the vicinity of other cities. In the Chicago area, for example, a once important onion area has been superseded by Texas onion growing. Climatic advantages, and lower labor costs offset the expense of transportation from these distant regions.

The town of Concord as a whole, however, has not followed the gardens in decline. During the period of truck farming Concord Center changed slowly into a commuting town. Improved rail connections, bus transportation, and new highways added in turn to the number who worked in Boston and slept in Concord. Now the commuters and their families outnumber the all-day residents of the area, and good farming land has been taken over by estates and subdivisions. The gardens therefore are threatened in still another manner.

Two paths into the future thus lie before the Concord area. It may continue as at present—a combination commuting town and garden district; or if Boston grows, it may expand further as a suburban residential center. If it is the latter, the gardens are likely to become extinct as commercial enterprises; if it is the former there will be an increasing Italian and Polish rural population, a complete revision of ideas of land value, and a diminishing list of articles grown in the area. Concord cannot say itself which it will be—that decision is left to Boston, whose proximity has determined the character of all of the other stages in Concord's development.

BEGINNINGS OF INDUSTRIALIZATION IN BURMA

O. H. Spate

THE geographer, especially if he be at work in a highly-developed western country, finds it easy to overlook the considerable proportion of the world's industrial energy which is devoted to the local processing of widespread agricultural products. Sporadic flour mills and breweries scattered in thousands of little market towns contribute severally little to national wealth or occupational statistics; but in aggregate their contribution becomes significant. Though they are not indeed independent of geographical influences, their highly generalized distribution gives a very slight basis for analysis, and their significance is not always easy to evaluate, precisely because of this wide distribution and what may be called their submergence in the general picture of economic activity. They were not of course always relegated to the background, as may be seen from the work of N. S. B. Gras, or from the lively picture of 18th century economic life given in Defoe's *Tour through Great Britain*. Attempts to assess the importance of these old agriculturally-based industries may fall into the opposite error of certain textbooks which are so eager to impress upon the student the ubiquity of, say, milling, tanning, and distilling in small Yugoslav towns that they cannot see the wood for the trees and miss the really vital topics.

The case of Burma, a country still in a very early stage of industrialization, does offer an opportunity of examining closely a development of this sort. The total industrial population is small and easily analyzed, and, far from the older type of local industry being eclipsed by huge manufacturing agglomerations, rice-milling alone accounts for about half the factory workers, and the up-country has developed at least relatively at the expense of the metropolis. While such other existent industries are definitely located in accordance with rather narrowly restrictive geographical conditions, rice-milling is very widely distributed, however, with significant variations in regional distribution of units by size. The detail of this distribution also reflects in very interesting manner certain social factors which complicate the economic life of the country, penetrated as it is by Indian capital which, though lacking the powerful concentration of European finance, has spread over the whole country within the framework of transport and legal facilities built up by the old British administration.

Rice naturally plays an overwhelming part in the economy of Burma, which still supplies over a third of the world's export (itself however, only a small fraction of world production). At present some twelve million acres are planted with paddy, i.e., about 70 per cent of the total cultivated area. In the Delta districts as a whole, this proportion rises to 90 per cent, but in the drier central area it falls to about 35 per cent and is largely dependent upon irrigation. The essential division of Burma proper (that is, the Irrawaddy basin) is climatic, into wet Lower Burma and the Dry Zone, the "Upper Burma Wet Zone" being relatively unimpor-

tant. (For a general account, see L. D. Stamp, "Burma, an Undeveloped Monsoon Country," *Geographical Review*, Vol. XX, 1930, p. 86.) But this simple division requires some elaboration. To begin with, there are the heavily wooded seaward slopes of the Arakan and Tenasserim Yomas (mountains) north and south of the Delta of the Irrawaddy respectively. These coastal strips are very wet (150 to 200 inches in general), and cultivation is limited by the broken topography: it reaches 25 per cent of the area in the northernmost districts of each region (Akyab and Thaton), and here some 21 per cent of the total area is under paddy.

FIGURE 1.—Distribution of towns and railways in Burma indicates certain concentration of economic activity in two nuclear regions, the Dry Zone around Mandalay and the Delta of the Irrawaddy.

The Delta, and the lower part of the Sittang valley which merges into it on the east, form the real export granary. Most of the region is practically dead level, with only few slight elevations, relics of older alluvial terraces, which rarely rise above 40 or 70 feet but are of great importance to human settlement. The whole region is intersected by a network of innumerable rivers and creeks which provide a ready-made system for the transport of paddy, whether by the steamers and launches of the Irrawaddy Flotilla Company or by country boat. The rainfall is 80 to 130 inches and rice is overwhelmingly predominant. In Hanthawaddy district, between Rangoon and the sea, it covers over 70 per cent of the entire area and nearly 95 per cent of the cultivated ground. Rangoon itself stands about twenty miles from the sea, at a point where a spur of older alluvium runs out from the end of the Pegu Yoma and provides a long causeway leading inland from the junction of three of the more important Delta streams. Besides possessing very good water nodality, Rangoon is the only spot commanding the approach to both the Irrawaddy and Sittang valleys by this invaluable causeway of high ground.

North of the Delta, the two districts of Toungoo on the Sittang and Prome on the Irrawaddy side of the Pegu Yoma are transitional between Lower Burma and the Dry Zone, and are conveniently referred to as the Sub-Delta. Rainfall is only 50 to 80 inches and irrigation begins to be significant.

In the Dry Zone rainfall is below 40 inches and this decrease is accompanied by unreliability, which does not affect Lower Burma. Rice still accounts for about a third of the total cropped

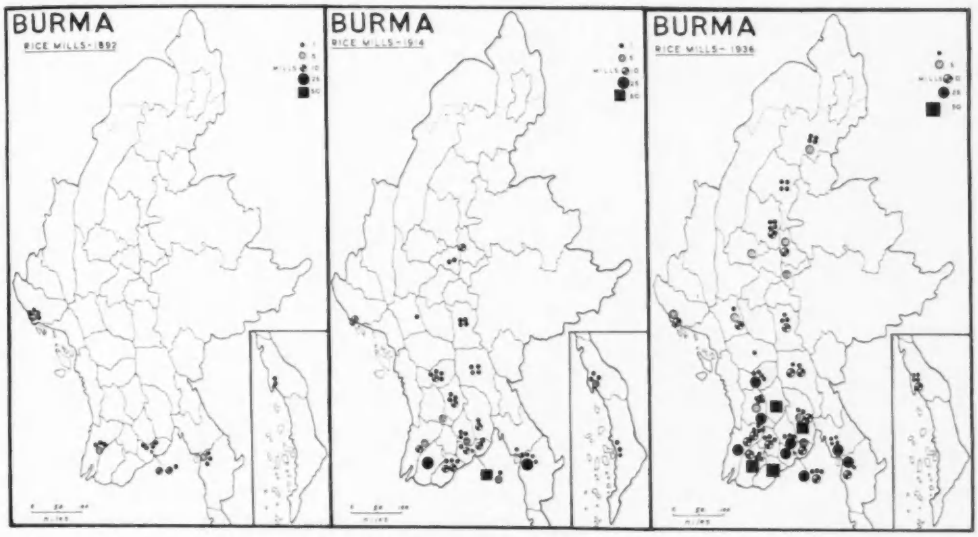

FIGURE 2.—Spread of rice mills, 1892, 1914, 1936. Rice milling was at first carried out only by big firms in the ports, but the introduction of cheap plants led to a big up-country development of small units.

area, but is only enough for local consumption and in some areas is entirely dependent on irrigation, e.g., in the ancient granary of the Burmese kingdom, Kyaukse. Crops such as cotton, groundnuts, sesamum and tobacco are important, and this is reflected in the industrial geography.

Finally in the north we have a rugged forested country with 60 to 80 inches; here only a very small area is cultivated along the river bottoms and in precarious shifting hillside clearings (*taungya*). The Shan States to the east are omitted from this survey as they have very little importance agriculturally (although some semi-temperate crops might be developed); industrially they have absolutely no significance except for the one mining center at Namtu.

Burma is predominantly an agricultural country; the number of industrial workers has barely exceeded 100,000, although there are a large number of small artisans working independently, as well as part-time domestic workers engaged, e.g., in the manufacture of cheroots. The size of the units is generally small, indicated by the fact that for purposes of inspection a factory is defined as an establishment employing twenty or more persons, or ten in the case of rice mills. Altogether at the end of the last war there were about 500 factories with 71,000 employees. As much of the subsequent expansion (shown in Table I) was accounted for by spread of small rice mills, the increases of factories and employees have not always kept in step; thus predepression peak number of factories has been surpassed, but the 1928 maximum of over 100,000 employees has never been regained. Reservations with which the figures must be considered are dealt with later.

It should be remembered that the numbers engaged in part-time handicrafts are often greater than those in the corresponding factory industry. Thus there are no tobacco "factories" in Burma, but in 1931 there were over 23,000 people engaged in making cheroots, either at home or in tiny workshops. Similarly there were some 42,000

TABLE I

Year	*Factories*	*Employees*	*Rice Mills*	*Employees*	*Average No. of Employees per Rice Mill*
1870	62	8,000	19	4–5,000	?
1880	74	11,750	49	c.9,500	c.190–200
1890			no figures		
1900	136	c.20,000	83	no figures	
1910	301	45,264	165		
1920	617	90,958	353	36,486	103.4
1921	711	92,585	429	42,063	98
1922	783	88,799	482	38,074	79
1923	855	86,642	529	37,553	71
1924	858	91,210	518	37,525	72.4
1925	893	99,546	543	38,823	71.5
1926	923	100,759	567	41,000	72.3
1927	940	101,350	572	40,300	70.45
1928	968	101,586	606	41,327	68
1929	976	98,077	608	39,645	65.2
1930	980	98,701	613	42,137	68.7
1931	947	90,593	589	41,790	70.9
1932	948	90,578	609	43,254	71
1933	942	86,433	618	41,302	66.8
1934	946	85,829	637	42,555	66.8
1935	965	90,322	647	44,944	69.4
1936	985	89,230	657	42,817	65.2
1937	986	87,652	650	39,990	61.5
1938	1,019	86,352	683	41,564	60.9

Figures from Administration Reports, supplemented by Census Reports and information obtained from the Office of the Labour Commissioner, Burma.
All figures before 1910 are approximate.

workers (nearly all women) with 144,000 "working dependents" engaged about equally in cotton spinning and in handloom weaving. This is really a part-time occupation of the younger women of agricultural families. This article is not concerned with cottage industry, and in any case the Census figures are really not suitable as a basis for analysis, as is shown by the fact that the numbers engaged in cotton spinning and weaving in the Southern Shan States were given as 834 in 1921 and as 54,106 in 1931. This phenomenal increase was probably due to the fact that weaving was given as a sample occupation in the specimen schedule for enumerators. It is only fair to add that relevant warnings are given in the Census Reports themselves and this case does not invalidate the general usefulness of the Census, given discreet handling. (Census of India, 1931—Vol. XI [Burma] Part I, pp. 131–2.)

It is evident from Table I that rice-milling is always responsible for from one-third to one-half of the industrial employment of Burma. The processes carried on consist essentially of the removal of the husk by friction. Owing to great differences in size and form of grain in various strains of paddy, an indefinite range of qualities can be produced; for western markets, final polishing has to be done in European ports. It is not necessary to particularize the various mechanical processes, except to call attention to parboiling. Paddy is steeped in water at about 100 degrees F. for 24 or 30 hours, subjected to low pressure steam for a few minutes, and then dried in the sun. "As a result of parboiling the husk is more easily removable, and as the kernel has been made tougher, parboiled paddy gives a greater out-turn of white rice than untreated paddy. Parboiled rice keeps better after milling, and as it does not turn sour readily after cooking

it is in demand by coolies working in plantations, who do not have time to devote to the cooking of more than one pot of rice a day. Parboiled rice is brownish in color, and although it is not appreciated in Burma or in western markets, it is in great demand in Ceylon, southern India, the West Indies, and in Africa." (J. W. Grant, *The Rice Crop in Burma*, Agricultural Department Survey No. 17, 1936, p. 34.) As less of the vitamin-rich husk is removed, parboiled rice is more nutritious than the ordinary cleaned rice. As generally carried out the process produces very offensive smells, and parboiling is mostly done at the newer and smaller up-country mills. A serious decline in the demand about 1930–31 added greatly to their financial difficulties in the general depression. Practically the only source of power in the industry is steam, as once a start has been made paddy husks themselves provide an inexhaustible supply of free fuel for small engines.

The industry has a very strong seasonal rhythm, as may be seen from the cartogram illustrating the movement of paddy to Rangoon in 1938 (Figure 5). The importance of water-borne supplies is well shown by this diagram: Kanoungto Creek and the Twante Canal to the southwest of Rangoon draw from the whole Delta as far as the main Irrawaddy distributary, an area overwhelmingly devoted to paddy. Rail-borne paddy is much less in bulk, and generally also of poorer quality, as it comes from the rather higher areas between the Pegu Yomas and the Delta proper, and along the Sittang (Figures 5 and 6).

The great impetus to commercial rice cultivation in Lower Burma came with the opening of the Suez Canal in 1869. The area under paddy rose from half or three-quarters of a million acres in 1852 (when Lower Burma was annexed) to nearly 2,000,000 in 1872–3 and to 6,750,000 in 1902–3. Before 1860 rice exported was mainly unhusked; there were a few small millers in Akyab (British since 1825) producing half-milled "cargo rice." The first steam mill was erected in Rangoon in 1861, and by 1870 there were about twenty—all in Rangoon except two in Akyab and one in Moulmein, the latter town being also part of the first annexation. As late as 1900 there were hardly any mills outside the four ports of Rangoon, Moulmein, Akyab, and Bassein. Between 1900 and 1914, however, small mills gradually spread along the railways from Rangoon to Prome and up the Sittang valley. In 1912 there were about as many mills in the Delta as in Rangoon itself (excluding in both cases

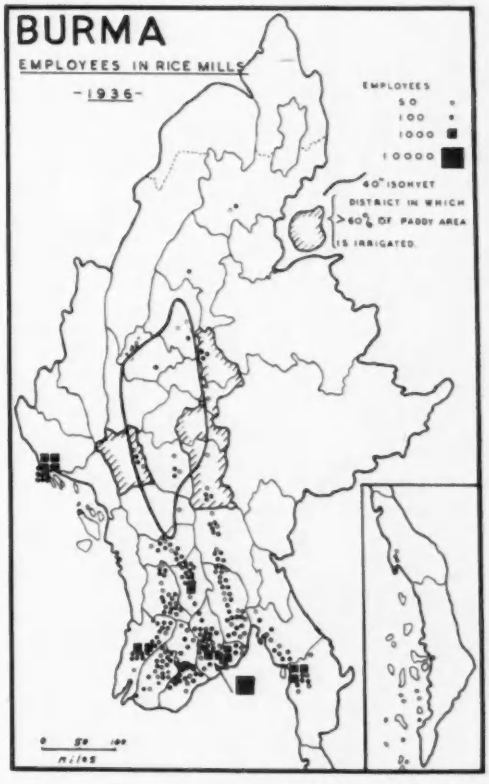

FIGURE 3.—A more detailed view of the distribution of rice milling shows how mills cling to the waterways and railways and avoid the Dry Zone.

the Hanthawaddy mills, grouped closely along the creeks in the near vicinity of the city). Outside Mandalay, however, there were not half a dozen in Upper Burma (Figure 2.)

The first few years after the war of 1914–18 were a boom period for Burma. The removal of war-time restrictions on the rice trade, the re-entry of Germany into world trade, the setting in hand of necessary public works delayed by war conditions, and the somewhat inflationary effect of the Local Government's windfall from Rice Control profits, all played their part in sudden expansion of business activity. This was most marked in rice-milling, owing to its intimate connection with the Rangoon rice market, where the post-war liveliness rendered a great deal of speculative capital immediately available. The increase was almost entirely in the number of small up-country mills. It should be explained here that the maps of industrial distributions are based on the triennial *List of Industrial Establishments* published by the Labour Commissioner. Only factories employing over ten persons (busy season average) are counted; and while the general trends are accurate enough, figures for any given year may be in error to some extent and show a time-lag. Thus the *Administration Report* for 1930–31 refers to a slight statistical increase in the numbers of mills and employees at a time when the slump had already definitely set in; this was probably due to improvements in administration and reporting. The close connection of the rice-milling population with the railways and the rivers, and in Upper Burma with the irrigated areas, is evident from Figure 3, as also the complementary distribution of rice-milling and of other industries based on Dry Zone crops (textiles, extraction of vegetable oils, etc.).

FIGURE 4.—Larger mills are still concentrated in the ports.

In the very active trade conditions of the earlier twenties the small mills had, initially at any rate, several advantages. Overhead expenses were relatively small and there was a good supply of cheap labor as the rush season for milling (February-April) coincides with the slack of the agricultural year. Up-country millers are able to keep in closer touch with the producer than are big firms in the ports and are able to secure the best paddy which comes on the market in small parcels. In Prome district this is very important; Sub-Delta paddies are generally poor but a special type is grown here for foreign markets and all milled locally. The local miller will often—perhaps generally—have a certain amount of paddy land which ensures him at least a minimum supply at low prices from his

tenants; and "the local miller can hold off from buying paddy for longer than the miller who is also a merchant and who in the course of business enters into contracts for forward delivery." This factor has of course a limited operation, and the general advantage of the up-country miller in being on the spot has been met by some of the larger firms establishing their own buying centers in Delta market towns. The small miller does much of his work on hire for larger firms and, especially in Upper Burma, he may mill the peasant's *wunsa* or paddy kept for subsistence, just as the local millers of medieval Europe did.

The introduction of cheap and efficient small milling units, generally of German make, is noted in the *Administration Report* of 1927–28 as greatly facilitating these trends; and the opportunities of escaping the attentions of an over-worked factory inspectorate was a definite incentive to the erection of smaller plants. In one case a miller set up two small mills, each employing under ten workers, in one enclosure, and was much aggrieved to find them grouped together and treated as a factory. Finally we may note the great saving in transport costs to the port, since 100 pounds of paddy produce on an average about 74 pounds of rice products, largely offset by revision of railway rates in favor of rice as against paddy. The fact that this took place in 1922, the year after the four great British firms which dominated the Rangoon market had formed a joint European selling agency called the "Bullenger Pool," led, not perhaps unnaturally, to a cry of discrimination in this and in other matters from Indian and Burmese interests.

There are certain definite disadvantages which must be faced by small mills. First and foremost is the lack of regular and cheap supply of capital.

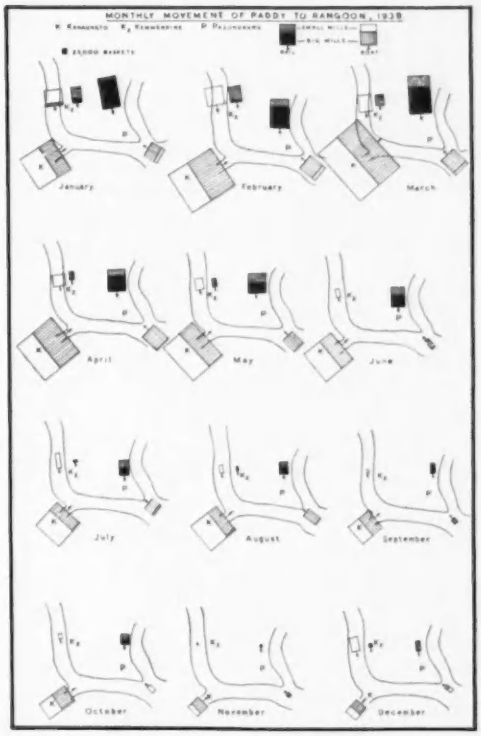

FIGURE 5.—Strong seasonal rhythm and predominance of waterways in paddy transit are clearly shown. For places mentioned in the legend see Figure 6.

Many mills were built under expansive influence of the boom; in many cases capital was advanced at low rates by exporting houses or by big millers at the ports, such advances being accompanied by forward contracts for delivery of milled rice. Some small millers however, fell to the temptation of higher prices later in the season and defaulted on their deliveries to lending firms, while in 1928 there was reversal of the usual tendency for prices to rise towards the end of the milling season, which alone made the system possible. The result was tightening of credit which imposed great difficulties on the small miller, whose plant was often mortgaged to secure working capital. With the depression moreover the Indian money lenders (Chettiars), whose rates were much higher (12 to 18 per cent) also

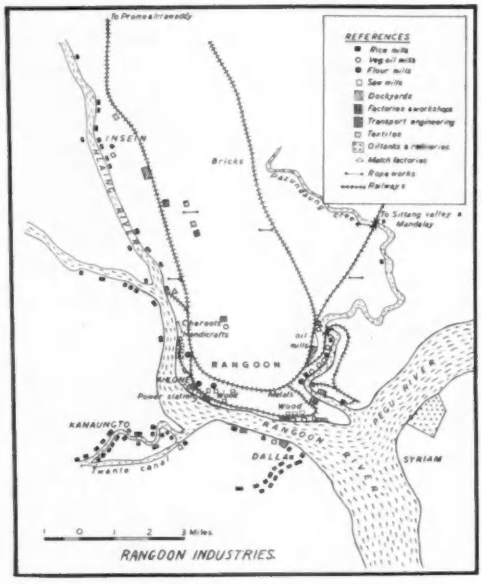

FIGURE 6.—Rice mills are clustered thickly about the creeks of Rangoon, especially those leading from the Delta. Heavier industries and sawmills are related to the main waterfront. The map also illustrates the excellent water nodality of the port.

restricted their credit facilities. (The Chettiars are a caste of Hindu money lenders from Madras who have played an enormous part in the development of Burma and who have come into possession of a great deal of land in Lower Burma as a result of the depression. There is a full account of their very curious semi-religious organization and activities in the Banking Report, 1930, Vol. I, pp. 189–243. This volume is a mine of information on the economic and social structure of the country.)

The great mills at the ports had also some more positive advantages. The really big mills are practically all European-owned, and most of them belonged to the four firms (one has since failed) which formed the Bullenger Pool. They had practical monopoly of the Western markets, expressed, *inter alia*, by a joint milling concern in Hamburg and by subsidiaries of Steel Brothers, the greatest of all, as far afield as Cuba and Palestine. They were also in a very strong position as agents for the shipping companies working to Europe; Steels' indeed was reputed to handle about three-quarters of the total European trade. It was also alleged that the Pool sold rice at a slight loss in the local market, especially when the Indian demand was strong; this naturally would depress the paddy price (to the detriment of the local producer), while the Pool could recoup its loss by European sales. It does not appear in fact that the Pool made excessive profits in 1928–30, when the agitation against it was raised; but the standing and credit of its components, its relations with the shipowners, and the influence inevitably wielded in the rice market by four firms which together milled a quarter or a third of the exportable surplus undoubtedly put the Pool in a very strong position *vis-a-vis* Indian or Burmese millers, especially when credit was contracted. But even in its palmiest days the Indian Ocean trade was mainly in Indian hands, while that to China was shared by European, Indian, and Chinese houses. The important trade in parboiled rice—15 to 18 per cent of the total—was mostly outside their scope, though Steels' began to take it up in 1932.

These are points of great importance in the economic and social structure of Burma. They are illustrated in Tables I and II. The great decrease in the average number of employees per mill is especially striking; from 1918 to 1921 it varied from 98 to 105; but by 1923 it had fallen to 71, and since then it has been between 60 and 70. There was slight increase in 1930–32, as some of the smaller and less economic units were shaken out by the depression, followed by recovery and in 1938 the number of mills reached its maximum of 683 and their average size its mini-

mum of under 61. It is seen from Figure 4 that mills employing over 100 hands are almost confined to four ports, of which nearly half (31 out of 72) are in Rangoon and its vicinity. In 1936 no less than 80 per cent of the workers in Rangoon were employed in establishments of over 200 hands each, as against about 33 per cent in the districts and 43 per cent in all Burma. According to latest figures (1938) Rangoon had 5.5 per cent of the mills and 18.8 per cent of the employees, with an average mill-size of 205 hands. Akyab however had the highest average size of 232. (Figures obtained through the courtesy of the Labour Commissioner.)

There are no proper figures issued on the important matter of ownership, but an approximate estimate can be worked out from the names of owners given in the latest (1936) *List of Industrial Establishments*. The chief source of error is probably underestimate of Indian ownership, for which there may be two reasons: a nominally Burmese-owned mill may be mortgaged to an Indian money lender or merchant, and (especially since the 1938 disturbances) an Indian may have a Burmese sleeping partner to lend his name. On the other hand, the Burmese total may not need any serious reduction, since some Chinese names probably belong to Sino-Burmans who have been assimilated to the Burmese proper. With these qualifications the following approximations can be obtained; they tally closely with independent government figures, although more recent statements suggest that the Chinese proportion should be higher.

As regards the distribution of these, the European mills are of course practically confined to ports, the exceptions being a very few small mills run by missions or by an occasional Anglo-Burman. Altogether the four ports and Hanthawaddy have 30 of the European mills and over eighteen thousand of their employees, of whom a third are in Rangoon itself. "Big Mills" (practically the European firms) take about half the paddy movement to Rangoon. Indians own over three-quarters of the mills in Insein district and over half those along the railway west of the Pegu Yomas into Tharrawaddy and Prome. They are, however, weak in the purely Delta districts, and especially so in Bassein, where competition is largely European; except for ubiquitous money lenders and petty traders, Indian enterprise is still largely centered in railway towns. Its great strength of course is the grip it has on trade to the Indian

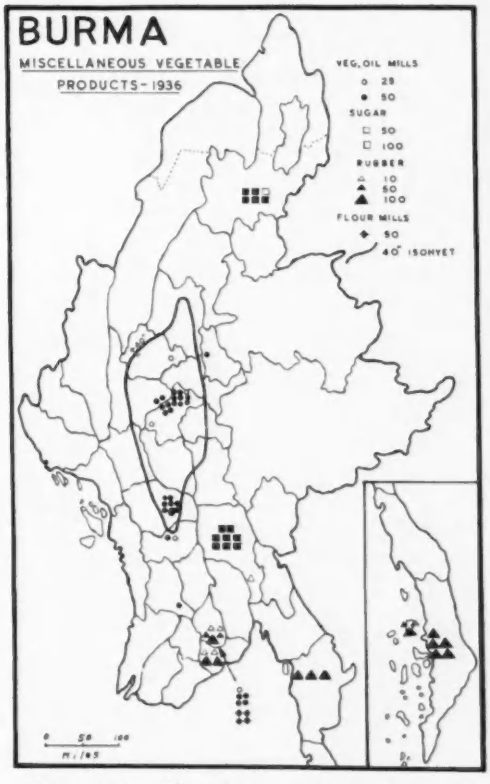

FIGURE 7.—Oilseeds in the Dry Zone, sugar in the Sub-Delta and the north, rubber in the wetter and hotter Tenasserim littoral. Cheroot-making is widespread, but in small workshops and as a cottage industry.

TABLE II

Community	*Mills*	*Percentage of Mills*	*Employees*	*Percentage of Employees*	*Average Size of Mills*
European, etc.	36	5.43	18,668	41.3	519
Indian	180	27.15	9,798	21.8	54.4
Burmese	346	52.19	13,733	30.4	40
Chinese, etc.	101	15.23	2,929	6.5	29
Total	663	100.0	45,126	100.0	68.1

motherland and its network of family and commercial connections. Indigenous milling affects the export market to slight extent only, except in so far as it is connected with Indian traders. Apart from actual export to India (which is, however, about half the total), Big Mills dominate the foreign trade.

Remarkable as development of Indian and indigenous milling has been, it is not perhaps an unmixed gain. Competition of so many mills may to some extent have benefited the cultivator by raising paddy prices, or rather by keeping them from falling so far as they might otherwise have done. Consuming classes, in Upper Burma especially, have also probably gained to some extent by the saving on transport costs on milled rice. But on the whole development has been very largely speculative, and already in the early 1920's it was suggested that Burma's milling capacity was in excess of the optimum. In 1930 it was calculated, on the basis of amount of paddy available and potential outturn of the mills of the province, that excess of milling capacity amounted to no less than 32 per cent. The not unnatural conclusion was drawn that "competition among millers to reduce overhead charges by trying to work to the utmost of their capacity is certain to lead to the extinction of the weaker units." However this investigation appears to have taken too serious a view of the case; to begin with, it included in the survey a large number of mills which had been closed down already (no less than 7 per cent of the numbers involved); and it seems probable that to some extent many mills are run only as a seasonal side line. Even if it were true that the milling capacity is more than enough for the available paddy over the year as a whole, it must be remembered that paddy comes on the market in a relatively short season, and it may be necessary to work for the peak period.

Proof of the pudding is in the eating. It is true that, as the Banking Enquiry suggested, the depression "shook out" many of the weaker enterprises, and on the whole improved the position by the bitter teaching of experience. But the setback was relatively short; although many mills were closed down, new ones were opened, and there are now more mills than ever. Much of the money invested, however, must be regarded as dead loss—or addition to the general problem of indebtedness. More serious perhaps than the general financial instability of the indigenous industry is diversion of local capital from more useful channels. It was noted in 1930 that extension of small electricity plants, of which there were then 110, had probably attracted some capital which would otherwise have been wasted on unnecessary rice mills. It is certainly true that there has been over-concentration on this one most obvious form of industrial enterprise.

Apart from domestic industries, which are notoriously difficult to revive, and peculiarly susceptible to political influ-

ence in the process, there is broad scope in Burma for subsidiary agricultural industries, generally outside the rice area, which would offset to some extent the present very dangerous approach to monocultural economy. Extension of rubber is limited by international agreement, but production of tung oil and arrowroot, improvement of tobacco and its processing (perhaps even development of a cigarette industry), more attention to fruit culture and perhaps eventually establishment of a canning industry (for pineapples) might be suggested. Such tentative experiments and investigations as have been made appear to be not unpromising. If on the one hand the first concession for bamboo paper was given as long ago as 1880, and a proposed plant in Arakan met with much local opposition as well as technical and economic obstacles in 1937, on the other hand tung seems to have made a prosperous start in the Shan States. While Burman opinion demands direct State financial aid—results of which have not been at all satisfactory in the past—it can hardly be denied that government activity in more hopeful directions has not been adequate. For example the work of the agricultural research stations is in itself excellent, but there is too little coördination between the various governmental agencies, and always difficulty of getting into real touch with the mass of cultivators remains. Machinery and drive seem to be concentrated on agricultural shows; when these are not regarded with suspicion (as a device to raise taxable capacity) the cultivator appears to treat them as opportunity for convivial celebration, with a few side shows such as exhibitions of fertilizers and insect pests, matters to which government attaches superstitious importance. That these difficulties are not surmounted is probably due at least in part to financial starvation; when a spokesman of the European Group in the Legislature draws a very unfavorable contrast between agricultural expenditure in Burma and in Malaya, it is clearly not a fanciful agitator's grievance.

Such agriculturally-based industries as have been established are complementary to rice milling in their distribution, except for rubber production and processing. This, however, is confined to the Tenasserim coast and the small Twante "upland" in the Delta near Rangoon. Sugar may perhaps be regarded as transitional; there is an important factory at Zeyawadi in Toungoo, with 800 employees and an annual output of about 20,000 tons, and another in the Northern Wet Zone with

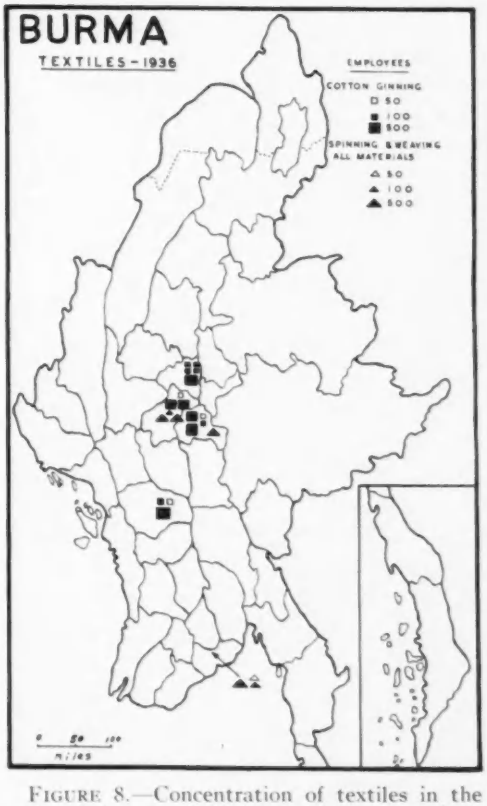

FIGURE 8.—Concentration of textiles in the cotton belt around Myingyan is very marked. Again there is a great deal of scattered domestic weaving, especially at Shwedaung near Prome.

about 550 hands. Under the Indo-Burma Trade Agreement, the industry has been accorded the same protection as that in India, but there is no tariff wall as between the two countries and in fact by the International Sugar Agreement Burma is India's only "foreign" market. As a consequence, imports of Java sugar have almost disappeared, while those from India have increased. The demand for white sugar is not, however, really very great and there are good prospects for Burman self-sufficiency if modifications can be introduced into the new trade agreement to protect the industry from Indian competition. In addition to large-scale factory production there is fairly important internal trade in various coarse sugar products from small local refineries, mainly Burmese; the trade itself is largely in Chinese hands.

The extraction of vegetable oils is important in Myingyan, Thayetmyo, and Prome districts, although the total engaged in factories coming under the Act is not very large. The three or four large mills employing 200 to 300 men apiece are owned by "Consolidated Cotton and Oil Mills," a subsidiary of Steels', and nearly all the export is cottonseed oil. Vegetable oils, however, play a part in the lives of the peoples of India and Burma far greater even than that played by olive oil in Mediterranean lands, and this is met mainly from sesamum and groundnuts. The position of the oil industry is not so satisfactory as that of sugar. There are about a million acres of sesamum and between half and three-quarters of a million of groundnuts, but so great is the demand for cooking and toilet purposes that export of vegetable oils is small, and there is actually considerable import from India. However quite a considerable amount of oil-cake is exported. The internal movement of oil and seeds from the Dry Zone is largely in Burmese hands; it seems probable that the truly indigenous demand is met from Burma, while import of sesamum seed and oil is milled and consumed mostly in Rangoon, and to some extent along the Rangoon-Prome railway, by the Indian community. As in the case of rice-milling, the introduction of small mechanical mills—sometimes by the ingenious harnessing of a small power plant to a battery of the local *hsizon* or mortars—appears to be leading to extension of the small-scale up-country element in the trade, a development naturally fostered by wide local demand. Other vegetable processing, except for textiles, is hardly carried out on an industrial scale. Cheroot-making is endemic, being carried on largely as a family occupation, but tobacco from the sandy islands of the Irrawaddy comes down to Danubyu near the head of the Delta, and cheroots made here have a more than local reputation and distribution. Flour-milling, dependent entirely on imported raw material and a very narrow market, is confined to Rangoon where there are three or four medium-sized mills.

Textiles, although employing in 1936 only some 6,000 to 7,000 people, deserve special mention. There are about 50 cotton ginneries with between 3,500 and 4,000 workers; over 3,000 of these are in Meiktila, Myingyan, and Sagaing—the Dry Zone cotton area. Most of the raw cotton goes to Japan (against a quota allowance for Japanese piece-goods imported) and it is of interest to note that two of the larger ginneries are Japanese-owned. Nearly half the 2,600 weavers were in one mill—Steels' at Myingyan; the only other big enterprise (about 600 employees) is an Indian-owned knitwear works near Rangoon. The rest are in the interesting local industry at Hanza village, Meiktila,

where a few small Burmese entrepreneurs employ about 500 to 600 workpeople. This represents the next stage above the purely domestic or cottage industry, which is still carried on. Recent political events and the anti-Indian feeling resulting from the 1938 disturbances led to a country-wide agitation to induce women to wear jackets of the home-produced *pinni* instead of the thin muslin which has been the traditional material. *Pinni* has the advantage of being durable, and it can be made from a buff-colored lint which is generally separated out at the ginneries as an impurity. Nationalist feeling was reinforced by alleged considerations of modesty, and the agitation certainly resulted in an increase in the number of women wearing *pinni*. But it must be remembered that the peasant woman working in the middy fields would naturally keep her muslin "for best," and many women continued to wear the older, cooler and more elegant style, carrying a *pinni* jacket to slip on at appropriate moments. In any case it has generally to be woven from imported—often Indian—yarn, and this offset the decline in imports of Indian piece-goods which did take place to some extent. It is possible that textile industries might be bolstered up for political reasons, and there have been various not very responsible suggestions of a high tariff on imported piece-goods. Protection for infant and for senile industries is an old song, but in this case the subject is hardly an embryo as yet.

Not very much need be said of the non-agricultural industries, which are in any case mainly extractive. The manufacture of consumption goods on an industrial scale is very little developed; after all the internal market is small (some fifteen million, but this includes many tribes hardly affected even by the local trade) and it does not make up for its small size by high purchasing power. Such development as there is has naturally been almost confined to Rangoon, and consists of a few match factories, rope-walks, aluminum and "battery" shops, soap boilers, and so on. Recent introductions include a maize-starch factory (erected for an Indian firm by a Danish company registered in Thailand) and a press being erected by the firm of De la Rue to print bank-notes and stamps for Eastern governments. Perhaps the most striking and successful is the Burma Cement Company (another protegé of the ubiquitous Steels') whose works at Thayetmyo have a capacity of 60,000 tons a year and turn out cement of excellent

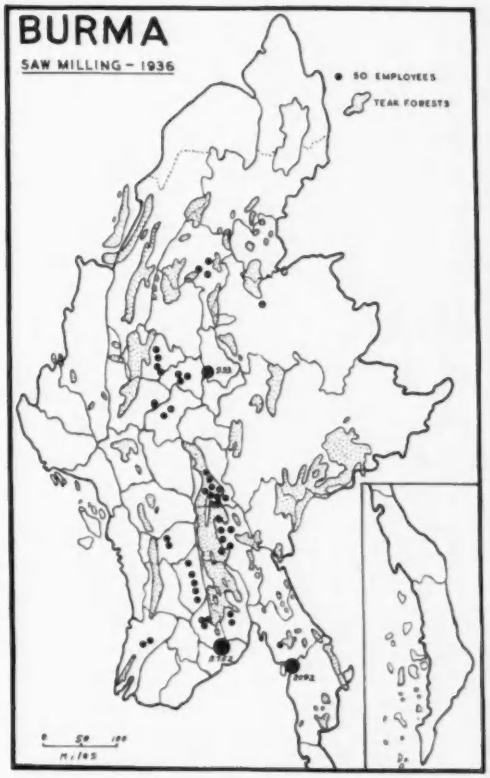

FIGURE 9.—Teak is the chief timber. Sawmills are largely located along the flanks of the Pegu Yoma and around the lower Chindwin. Moulmein draws on the otherwise little-developed Salween area.

quality from a group of limestone hills near the bank of the Irrawaddy.

Chief of the extractive industries is saw-milling, which comes second to rice-milling with 12,000 to 13,000 employees, followed by oil-refining with 9,000 to 10,000. There is nothing very striking about the distribution of timber industries: a little in the Upper Burma Wet Zone, a good deal in the otherwise little-developed Lower Chindwin area, and in Yamethin and Toungoo, where teak logs come down from the lower slopes of the Shan Scarp on the one hand and from the Pegu Yoma on the other. But the great centers are Rangoon (nearly 6,000) and Moulmein (2,000). Big rafts of timber are floated to the Government Timber Depot in west Rangoon and the cluster of saw-mills on the nearby creeks which fall into the Rangoon River, while Moulmein, at the mouth of the Salween, taps the otherwise useless jungle in the wild country of Karenni and the Thailand border.

Mining in Burma would deserve an entirely separate treatment; it is sufficient to note here that the concentrations on the Yenangyaung oilfield and the Namtu silver–lead area in the Northern Shan States have of course a relatively large industrial element. The Burmah Oil Company at Yenangyaung and at its Syriam refineries opposite Rangoon carry on a great variety of maintenance operations; the 6,000 workers at Yenangyaung are engaged in "machine shops, gasoline plants, pump stations (water, oil, and gas), mud-mixing plant, oxygen plant, ice plants, etc.; various units for making soda-water, and for gas-collection, gas-boosting, pipe-threading, armature-winding, repairs to all kinds of plant; also a rope-way and a bakery," not to mention schools and hospitals. Apart from the oilfields and Namtu, most of the engineering work is concentrated at or near Rangoon and Mandalay, where the Burma Railway shops and the Irrawaddy Flotilla dockyards employ between them some 4,500 men—a very large proportion of the total engaged in engineering and metallurgical industries. There is of course a great deal of public constructional work, for instance the Pegu Yoma water supply scheme for Rangoon, which has its group of associated supply industries such as pipe-factories.

Except for one fairly large but precariously over-developed industry, and a few extractive occupations such as saw-milling and oil-refining, Burma's industrial development is then, negligible; and what there is is almost entirely in European or Indian hands. Naturally this state of affairs has led to considerable criticism, not only in more nationalist quarters; but little that is constructive has emerged. Although the country can hardly be considered as exceptionally well-endowed, she is by no means poor in natural resources. On the agricultural side, the Delta will probably remain a monocultural area, attempts at a second crop having to face, among other things, a ground baked hard as bricks after the harvest. In the Dry Zone really large extensions of cultivation under present conditions would be marginal, and the provision of irrigation is a slow and costly process in the prevalent physical conditions. "Considering the natural conservatism of farming classes the dry zone cultivator in Burma has shown remarkable enterprise in his readiness to adopt new methods. In most centers where demonstration has been conducted for three or more years there is now a group of cultivators making a serious attempt to follow a better farming system." There is wide scope for quantitative and qualitative improve-

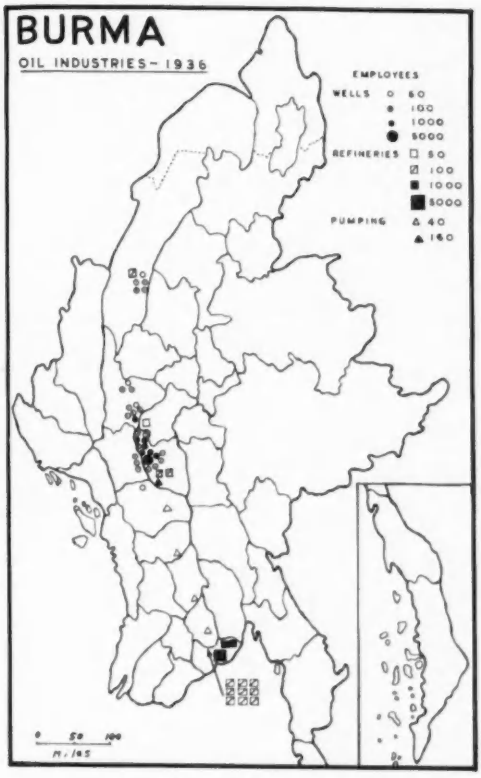

FIGURE 10.—The oilfields are in the Irrawaddy "Tertiary Gulf." The Syriam refineries are the largest single industrial unit in Burma.

ment of yields and the diversification of culture. But progress is hampered at every turn by lack of capital and by the middleman problem; thus "70 per cent of the growers get their supplies of cottonseed from the traders . . . the outstanding feature of the marketing system, and one which interferes seriously with any attempt at the establishment of an improved strain, is the indebtedness of the grower and his obligation to the village trader to whom a large proportion of the crop is pledged before picking commences."

Despite numerous difficulties, more could be done to keep a greater proportion of the working-up of crops like cotton in the country, to develop new industrial uses for many of the crops, and to meet some of the demand now catered for by imported consumption goods. A policy which aimed at fostering first of all such unspectacular but useful trades as leather-working and pottery-making would probably yield better results than ambitious schemes, such as seem to be desired by a section of the Burmese Press, for setting up complete large-scale industries (such as textiles) as it were ready-made. The local pottery is plain but satisfactory in appearance (when not "decorated" with atrocious semi-European designs) and the subsidized pottery works, an unfortunate experiment in most respects, at least showed that attractive glazed ware can be produced. Such industries might do something to remedy the chronic under-employment which is at least a contributory factor to the prevalence of dacoity, and would certainly be useful in providing an addition to rural incomes, even allowing that the need for employing the cultivator's time in the off-season may have been somewhat exaggerated in the past. A rest-spell after the gruelling labor of planting and harvest is probably more a necessity than luxury, at any rate if a decent life rather than mere existence bound to the soil is regarded as desirable; but the present off-season is too long and an extension of rural industries, if attainable, would certainly be socially useful. But conditions do not seem to be present for rapid industrialization in the modern large-scale manner. Conclusions of the London and Cambridge Economic Service on the fundamentally not dissimilar problems of the Balkans apply *a fortiori* to Burma: "It may be doubted whether industrialization is really a sound remedy . . . the cost of producing manufactures is high (owing to lack of skilled labor, or of good local fuel and raw materials, or of a sufficiently large home demand) and industries prosper only behind high protective

barriers . . . industrialization benefits mainly the towns. In any event, industry employs only a small proportion of the total population."

Moreover, external factors are perhaps discouraging for Burma's autonomous industrial development. By the Indo-Burma Trade Agreement, free trade with India was to run initially for three years from the date of Separation (April 1, 1937) and notice has been given by Burma for a new negotiation. In some cases there is probably substance in the claim that Burma would be benefited if she could pursue an independent fiscal policy. Burma is a valuable market for all sorts of Indian manufactures, some of which (e.g., cheap rubber goods) could possibly be produced at home. The adoption by Burma of an aggressive tariff policy, which is favored by some sections, might, however, expose her to severe retaliation in the form of import duties on Burmese rice entering India which, while it amounts to only a small percentage of India's consumption, represents about 60 per cent of Burma's export. It is true that the demand is inelastic and the possibilities of rice expansion in India very slight, while it would take time to re-orientate imports from Indo-China or to spread wheat-eating habits. The Indian consumer and the Indian trader in Burma would suffer, and this would of course have great weight; but even so a relatively slight discrimination could hardly fail to have a most severe reaction on the already bad position of the Burmese cultivator. Talk to the effect that a boycott of Burmese rice would enable the peasant to eat more himself merely adds point to the old epigram about the Burmese being the Irish of the east. Similar economic views are alleged to have been held by an Irish senator, who is said to have affirmed during the tariff war with England that if need be Ireland would eat her own butter: 1,100 pounds per head per week! On the whole a policy of live and let live would appear to be as essential to Burma as to other nations, although no doubt the expiration of the Agreement is being used to secure modifications.

The root causes of Burma's undeveloped position are two: lack of capital and, it must be confessed, lack of commercial initiative. Burma is far from being over-populated, but labor is there; restriction of Indian immigration, now much in the air, might hamper a rapid capitalist development, although there are tenable social arguments on both sides. If the Burmese laborer is more happy-go-lucky than the Indian, he is no worse as a cultivator, and there are not wanting signs that the impact of *soi-disant* progress is changing his undeniably pleasant but old-fashioned attitude to life. Simple mechanical ability exists and could be fostered. Although the country is not very richly endowed, it is not, on the other hand, unduly deficient in natural resources. But the twin problems of capital and enterprise remain.

The capital problem has been and will continue to be the subject of much controversy. Burma is essentially a new country economically; it is not long since there was a pioneer fringe. The tradition and outlook of the people do not encourage the accumulation of wealth. In the old days money once gained was devoted (apart from immediate needs) to religious purposes, the building of pagodas or the entertainment of monks, or to general celebrations; and on a lesser scale this type of uneconomic expenditure still persists. It is a very human trait, but not conducive to industrialism. The accumulation of capital again is seriously hindered by inability of Burmese Buddhists

to make legally valid wills. This does not seem to be inherent in Buddhist doctrine (although primitive Buddhism, like primitive Christianity, might be held to have some very non-capitalist implications). Attempts have been made by Burmans themselves to end this unsatisfactory state of affairs, but even nationalist papers have opposed them on religious grounds. At all events the results are sufficiently obvious: "A frequent result of the enforced division of the property of a deceased person is that the value gets broken up into parts which are separately too small to be of much use . . . often the shares are frittered away. . . . Many more inheritances are dissipated in the law courts than in countries where wills are made; legal disputes among the heirs of a person of substance almost invariably arise . . . parental control is weakened and thrift discouraged . . . even in the lifetime of one of the parents a partition of the estate is often effected. The elaborate partitions of property under Buddhist law also cause a large part of the difficulty of instituting a system of registration of titles in land," and this in turn increases the mortgagee's risks and so tends indirectly to force up the rate of interest.

In such circumstances capital remains almost a monopoly of the Chettiars and rates are very high; it is only fair to add that risks are high too, and that Chettiar rates are lower than those of other money lenders. There is a certain readiness to live in debt, due perhaps less to original economic sin than to the optimistic boom conditions in which the Delta developed, which almost put a premium on irresponsibility: "The Burman cultivators had a special temptation in that they had to pass through the revolution from a natural to a money economy just when the expansion of credit took place. . . . The Burman was still a novice in the new economic system; the Chettiar was an expert in money and his teachings were accepted." From 1900 to 1908 paddy prices rose by 50 per cent and there was no limit to "easy money." Now that a large proportion of the land in Lower Burma has passed into Chettiar hands as a result of the 1931 depression, an agrarian crisis is not impossible. Such an event would of course have a most unfavorable effect on Burma's credit and still further hamper development.

As regards lack of initiative, the most casual observer in Rangoon and even up-country is at once struck by lack of Burmese enterprise. A few printing-presses, a few film companies, a very few good shops, some rice-milling and

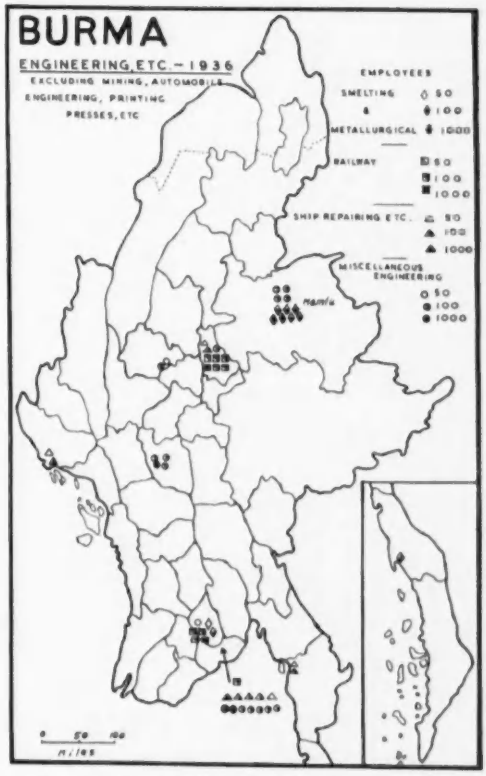

FIGURE 11.—Concentration in ports, oilfields, the suburbs of Rangoon, and the Namtu mines.

brokerage, some small-scale mining, and that is practically all. More complete study merely confirms first impressions. Of course the mere fact that bigger undertakings are already in foreign hands has a depressing effect, quite apart from very solid material advantages of such entrenchment. But when all allowance is made it must be confessed that there is little sign of any resolution to tackle the problem and make best use of such Burmese resources as exist. Such attempts as are made are often made with little appreciation of commercial principles; birth and death rates for rice-mills and printing-presses are both very high; spread of motor transport has been remarkable, but even in such an industry little thought seems to be taken for such items as depreciation of vehicles. In fact the situation can hardly be summed up more clearly than in a speech by one of the leaders of the country: "Business must be interpreted in the Burmese sense, of small-scale trading; not in the un-Burmese sense of enormous enterprises, which are foreign to the genius of Burmese life." Indeed they are; but they exist in Burma and their existence in foreign hands cannot fail to complicate political and social life at every turn. It is not easy to determine whether the irony in the sentence just quoted is unconscious or no; but it does reflect with clarity and certainty the hopeless outlook for Burma's embryo industry.

Note: All maps illustrating this article were redrawn by Tin Hla Maung, Cartographer in the Geography Department, University College, Rangoon.

PHOSPHATE LANDS OF TENNESSEE

H. Thompson Straw

THE past few years have seen an increasing amount of attention, both governmental and private, directed toward the problems of agriculture, especially those related to soil depletion. Of the various elements, the lack of which would produce this depletion of the soil, phosphorus seems to be the most vital. Certain other elements such as potash are usually present in sufficient quantities so that they do not create a problem. Nitrogen, although as necessary to plant growth as phosphate, can usually be supplied by the growth of legumes. Phosphate, in contrast, is not present in large quantities, particularly in most of the pedalfer soils in eastern United States where the major portion of our agricultural lands is found, and there is no way of supplying this deficiency save by the application of fertilizer rich in this element. The usual source of phosphatic fertilizer in this country is phosphate rock—hence the increased interest in those deposits which we possess, not only from the standpoint of local exploitation, but from the larger standpoint of national well being.

The importance of the phosphate lands of Tennessee to the nation as a whole does not arise from either the extensiveness or the richness of their deposits but from the fact that Tennessee, despite small reserves, has been for a number of years second only to Florida as an American producer. The distribution of the commercially important phosphate lands in Tennessee can be seen on the map (Figure 1). It will be noted that they are mainly confined to the western part of the Central Basin and associated portions of the Highland Rim Plateau, although locally they extend across the Tennessee River. It is along this river that the white phosphate, apparently redistributed from solution and of post-Tertiary age, is found. In the eastern part of the Highland Rim Plateau with smaller deposits along the upper course of the Buffalo River are the bedded deposits of blue phosphate of Devonian age. In the Central Basin but restricted to that portion lying near the Western Highland Rim Plateau is the brown phosphate, of residual character and of Ordovician age.

Locally, with the exception of the white phosphate, these areas are well supplied with transportation. The brown phosphate fields are served for the most part by the main lines of the railroad (Figure 1), and the blue phosphate fields are largely served by railroad spurs which have been built to the mining areas. Much of the white phosphate may be said to have poor rail service. To some extent, however, this lack is compensated by the presence of the Tennessee River which can be used as a means of transportation. The general adequacy of transportation and the position of these deposits in the United States have made it possible for them to supply the fertilizer markets of the southern states and of the eastern part of the middle western states.

Tennessee rock was first placed upon the market in 1894. Its production since that date can be seen from Figure 2. This production has always been, as we would expect, closely related to

the general agricultural conditions of the country. Thus the first peak was reached in 1907 and was followed by a sharp decline during the depression years which ensued. The very rapid rise from 1918 to 1920 and the even more rapid decline from 1920 to 1922 mirrors the fluctuation of agricultural prices during this period. The industry was recovering from the low period of 1922 when in 1929 the world depression caused the greatest decline it had ever known. The present unprecedented rise may in a degree have been due to a partial recovery from this depression, but it is largely due to the introduction of new methods in phosphate production which will be discussed later.

WHITE PHOSPHATE

Of all the varieties of phosphate in Tennessee, the white has been the least important from the commercial standpoint. These deposits are of small extent and are scattered along the Buffalo and the Tennessee rivers. Since the area has not been so carefully prospected as those of the brown and the blue phosphate, there are probably many small deposits which are not indicated upon the map. The areas which have been of greatest commercial importance are those near Decaturville, along Toms Creek, and immediately north of Linden. Most of these deposits are of a lamellar nature and occur as plates of various thickness cemented together, thus forming boulders.

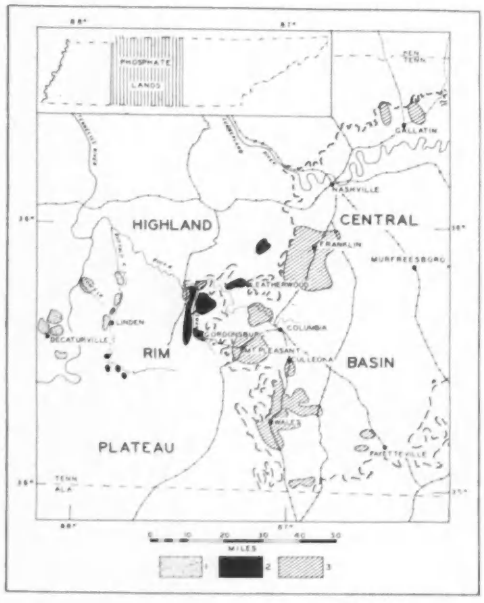

FIGURE 1.—Phosphate lands of Tennessee. 1. White phosphate. 2. Blue phosphate. 3. Brown phosphate.

Irrespective of whether the character of the deposit is lamellar, brecciated, or stony, white phosphate seems to be a recrystallization of calcium phosphate either in caves or elsewhere beneath the surface of the ground. The scattered distribution of deposits has necessitated careful prospecting which has added to the cost of production. Mining is generally done by the opencut method although tunneling has been resorted to where the overburden has been found to be excessively thick. However, the loose character of the overlying clay requires such extensive timbering and thereby adds so materially to the cost of operations that tunneling has been generally discouraged. Although white phosphate has the highest B.P.L. content of any of the Tennessee phosphates and even where its mining can be carried on by the cheaper opencut method, the white variety has found it difficult to compete with the more cheaply produced blue and brown phosphates. (B.P.L. means bone phosphate of lime and is the usual method of indicating the content of tri-calcium phosphate in phosphate rock.) Since its scattered occurrence has added to the cost of both prospecting and mining, the development of these deposits has for the most part been sporadic, largely restricted to periods when the price of phosphate rock was generally high. The latest development came through

the Tennessee Valley Authority. Considerable amounts of white phosphate were purchased for use in the fertilizer plant at Wilson Dam, Alabama. Much of this phosphate was mined by individual farmers, hauled by truck to the Tennessee River, and shipped by barge to the Tennessee Valley Authority. Large-scale commercial development of white phosphate has in the past been centered mainly about Decaturville.

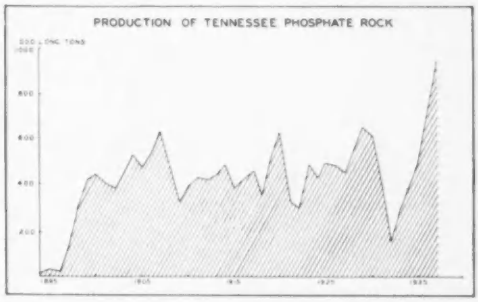

FIGURE 2.—The production of Tennessee phosphate has been in the past closely related to the fluctuation of farm prices. Peaks of production were reached in 1907, 1920, and 1929. The present rapid rise, 1932–1937, seems to be at least partly due to the experimentation and operations of the Tennessee Valley Authority in the area. (Sources of data: *Mineral Resources* and *Minerals Yearbook, 1895–1938.*)

BLUE PHOSPHATE

Far more important and extensive than the deposits of white phosphate are those of blue phosphate. Located almost exclusively in the Highland Rim Plateau (Figure 1), the major deposits are near Leatherwood, along Swans Creek, and a few scattered ones along the upper course of the Buffalo River.

Hayes (The Tennessee Phosphates. Seventeenth Annual Rept., U. S. Geol. Surv., Pt. II, 1896, pp. 525–7.) recognizes four varieties of blue phosphate only two of which, the oölitic and the compact, are of commercial importance. These rocks are unaltered phosphatic portions of the Harden sandstone, a rock of Devonian age, which in the Highland Rim Plateau usually lies directly beneath the Chattanooga shale. The colors of the phosphate rocks range from bluish gray to black save in the few places where they have been sufficiently weathered to possess an appearance not unlike rusty brown sandstone. The texture of the compact variety is finer grained than that of the oölitic, and consequently it is crushed during the processes of mining and preparation with greater difficulty.

The mining of the blue phosphate is generally similar to that used to extract thin coal beds. Occasionally the open-pit method is used, but for the most part the overburden is too great, and it is necessary to resort to running drifts and digging the phosphate out in rooms (Figure 3). Near Gordensburg, where extensive mining has been carried on, the shale which is about three feet thick and overlies the blue phosphate is partially cut away and the phosphate is blasted from the hard limestone on which it rests. It is then loaded into cars and dragged from the mines. The overlying shale which remains in the mine is of sufficient thickness and strength to form a roof at least for the duration of ordinary mining operations, thus saving the cost of extensive timbering (Figure 4). In other areas of blue phosphate the shale is either thin or absent and the phosphate is capped by a weaker rock, such as the Fort Payne chert. Under these conditions extensive timbering is necessary and the cost of mining is thereby increased. This has resulted in many areas of blue phosphate remaining undeveloped.

Although the blue was the first of the phosphates to be exploited, it has been far less extensively developed than the brown. The two areas of greatest commercial development have been near Gordonsburg and Leatherwood. The deposits near Leatherwood were known for some time before they

were utilized, but their development had to await the building of a railroad from Mt. Pleasant to Franklin through the area. The Gordonsburg mines are served by a spur from Mt. Pleasant.

Even under almost ideal conditions such as those existent at Gordonsburg, the blue phosphate is more expensive to mine and has a lower B.P.L. content than the brown phosphate of the Central Basin. Not only are the actual costs of mining greater, but the cost of prospecting is also higher. Core drill holes made at regular intervals are necessary to determine the advisability of digging any particular tunnel, for even where the outcropping is unusually thick the phosphate stratum, owing to its irregular occurrence, may within a short distance suddenly thin out or disappear. The compensating advantages of the blue rock are: first, that unlike the brown it requires no expensive washing and sorting process, but merely crushing, drying, and grading as the preparations necessary for market; and second, its ease of manufacture into acid phosphate for the fertilizer trade. The blue rock requires the addition of less sulphuric acid, combines with the acid more readily, and dries out more rapidly after treatment than does the brown. The minimum requirements for extensive commercial development of the blue phosphate in the past have seemed to be: the presence of a sufficiently strong shale overcapping to eliminate the cost of extensive timbering; the stratum, at least eighteen inches thick; and a B.P.L. content of at least 65 per cent. Much of the blue phosphate which remains does not fulfill one or more of these requirements and hence is undeveloped today. Even some of the deposits which were formerly extensively worked have had the higher grades of phosphate removed and are today no longer mined (Figure 5). Extensive development of the blue phosphate, like that of the white, must apparently await higher prices in the phosphate market.

FIGURE 3.—View of blue phosphate mine opening near Gordonsburg.

BROWN PHOSPHATE

The brown variety is by far the most important of all the phosphates in Tennessee. It is on these fields that the major part of the phosphate industry is located, and here the newer developments of the industry are taking place. The brown deposits are located almost exclusively in the Central Basin (Figure 1), but are restricted to the western edge at or near where the Basin joins the Highland Rim Plateau. The brown phosphate is associated with more than one formation, but each of the formations is phosphatic limestone of Ordovician age. Most of these limestones are dense, often bluish and crystalline, but banded with thin dark blue, granular layers which contain the richer phosphate deposits. The chemical content of the limestone varies from one formation to another and even within the same formation in different localities. In general, however, most of the unweathered limestone contains from ten to twenty per cent tri-calcium phosphate.

However rich the original limestone is in tri-calcium phosphate, it still remains unimportant commercially unless leached by acid ground water

charged with carbon dioxide. In this way the calcium carbonate of the limestone is removed and the less soluble tri-calcium phosphate and impurities remain, forming the phosphate rock and associated muck. It has been estimated that one foot of the original limestone weathers to one inch of phosphate. (Chas. W. Hayes and E. O. Ulrich, Description of the Columbia Quadrangle [Tenn.]. U. S. Geol. Surv. Atlas, Columbia Folio No. 95, 1903, p. 6.) Not only is the phosphate rock enriched by leaching but also by redeposition from higher strata, since leaching alone would not produce a solid rock but only phosphate sand. The extent of the leaching of the Ordovician limestones is closely related to the tectonic disturbances which the Central Basin has undergone. The deeply incised rivers which drain the Basin point to a rather recent uplift of the area. This has allowed the ground water to penetrate to a lower level than formerly, and thus has increased the extent of the leaching process. It has also produced abundant jointing of these limestones, caused by fracture during the uplift. Along these joints the ground water was best able to work and consequently it is here that the thickest deposits of phosphate rock are found.

Because of this irregular leaching and redeposition the phosphate rock appears as a thin, horizontal layer of varying thickness deposited in wavy lines and associated with a considerable portion of loose phosphate sand mixed with muck. The bottom of the beds is interrupted by large blocks of unleached limestone called "chimneys" or "horses." These chimneys vary greatly in size and shape, largely depending on how numerous the joints were in the original limestone. The phosphate rock appears as a loosely coherent but porous brown sandstone. The rock and associated sand and muck where the deposits are rich enough to work is of a thickness of rarely less than three feet and often is from six to fifteen feet. The more extensive deposits are of the blanket type and occur where the Ordovician limestone was exposed at or near the surface. Where the Ordovician limestone is capped by a non-phosphatic limestone and appears only on a slope the limited deposit, following the outcrop and known as the collar type, is found.

The mining operations in the brown phosphate region are the simplest encountered in any of the phosphate fields. The overburden is seldom more than a few feet thick and nowhere presents a serious problem. In the early days of phosphate mining most of the work was done by hand. The rock was loosened by pick and removed by fork and screened (Figure 6). After being piled in the sun to dry the rock was sold directly to the fertilizer companies. Fortunately, from the standpoint of conserving phosphate deposits, this very simple method is but little used today, for by it only the phosphate rock is extracted and the sand is left untouched. A few farmers still carry on small operations by this method, but the industry has come to depend for the

FIGURE 4.—A tunnel into a blue phosphate deposit opened in the spring of 1937, shortly before the mines closed down. Note the thick layer of shale overhead.

FIGURE 5.—Ruins of the old drying shed for blue phosphate rock at Gordonsburg.

bulk of its raw material upon the far more efficient methods used by large-scale producers.

In large-scale mining operations the overburden is first stripped off by the dragline (Figure 7), and the underlying phosphate rock, sand, and muck are dumped into cars and trucks and thus hauled to the washer (Figure 8). At this stage the B.P.L. content of the freshly mined mass is low, since it contains considerable amounts of clay and chert. The washer and drying plants are designed to eliminate these deleterious substances and to concentrate the tri-calcium phosphate. In a few favorable localities the use of the dragline is dispensed with and hydraulic mining is substituted. Since most of the deposits occur on a relatively level plain, however, this method is practical in but few places.

At the washer the material is crushed, the chert screened out, and the remainder mixed with water. Because the phosphate sand and small rock fragments are heavier than the clay with which they are mixed, a separation can be effected by allowing the phosphate to settle to the bottom of a tank and the clay to be removed in suspension in the water used in this process. In certain of the deposits, as those near Wales (Figure 1) where the silica content of the phosphate mass is usually high, the tri-calcium phosphate is removed by flotation, a process by which the phosphate is collected as it is buoyed up by a special oil and the silica allowed to settle. After the B.P.L. percentage has been increased by these methods, the resultant product is dried, graded according to size, and stored.

On the one hand, the machinery which makes possible this very efficient method of mining has greatly increased the capital outlay of the industry, but, on the other hand, its very efficiency has established the supremacy of the brown phosphate fields over the blue and the white and has maintained the industry long after the bulk of the high grade phosphate rock, the only product of the earlier inefficient hand methods, has been exhausted. Indeed, so efficient is the present method and so small is the amount of recoverable phosphate lost by it that it is difficult to conceive of any improvement. Present trends in increased efficiency in phosphate production bear out this conclusion, for they appear to be along the lines not of an improvement in the old methods but the adoption of radically new ones for the production of a new type of fertilizer.

TREATMENT OF PHOSPHATE ROCK

The uses of phosphate rock in the United States are shown on Figure 9. The treatment which the rock will receive subsequent to mining will of course depend upon its intended use. However, since most of it is intended for use as fertilizer, a description of the treatment of phosphate rock will be largely restricted to that intended for this use.

The simplest preparation of phosphate for fertilizer is for that which will be used by direct application to the soil. Only about two per cent of the total amount mined in the United States is so used (Figure 9). Tri-calcium phos-

phate, as has been shown, is relatively insoluble in water, and hence the advisability of applying the ground rock as fertilizer has often been questioned. The conclusions which have been reached after considerable controversy among agricultural experts seems to be that if the rock is very finely ground and liberally applied, and if the soil to which it is applied has a high humus content, that soil will be improved by the application although far less rapidly than if the rock were first treated with acid. (Wm. H. Waggaman and Henry W. Easterwood, Phosphoric Acid, Phosphates, and Phosphatic Fertilizers. Chem. Cat. Co., N. Y. C., 1927, p. 49.) The change from an insoluble tri-calcium phosphate to a soluble form is effected by acidulated ground water which attacks the calcium of the compound, thus freeing the phosphoric acid for plant use. Most of the rock for direct application in the United States comes from the Tennessee brown phosphate fields and finds its largest market in the prairie states of the Middle West. The only preparation necessary is drying and very fine pulverization.

The largest amount of phosphate rock (61 per cent) used in this country is in the form of superphosphate (Figure 9). To produce this superphosphate, rock phosphate is pulverized and carefully mixed with sulphuric acid and water. The sulphuric acid combines with two-thirds of the calcium in the insoluble tri-calcium phosphate, and this combination plus the water present becomes gypsum. The remainder, mono-calcium phosphate, is soluble in water and hence an available plant food. Considerable care must be exercised in mixing the rock and the acid. If too much acid is used the resultant product is mechanically undesirable, since it remains wet and sticky and cannot be easily applied to the fields. If too small an amount of acid is used, the resultant product may contain too small an amount of mono-calcium phosphate. The phosphate fertilizer industry in Tennessee is fortunately located with reference to a supply of sulphuric acid. This acid is produced in Ducktown, Tennessee, as a by-product of copper smelting. The requirements for the raw rock used for superphosphate are that it must have at least a B.P.L. content of sixty per cent and must be relatively free from aluminum and iron compounds. It will then form a finished product which will contain from sixteen to twenty per cent available plant food. If the B.P.L. content is lower than sixty per cent, the resulting product will be too low in available plant food to be readily sold; if too high in iron and aluminum, the resultant product is mechanically undesirable. By these standards much of the phosphate in Tennessee today is not suitable for fertilizer production.

There is available in this country, although but little used, another method of producing phosphate fertilizer from rock. Poor grades of phosphate rock are mixed with an excess of sulphuric acid which liberates phosphoric acid from the tri-calcium phosphate of the rock. The excess sulphuric acid and phosphoric acid are filtered from the

FIGURE 6.—Mining brown phosphate rock by hand near Columbia. Since much of the phosphate is not recovered by this method, it is fortunate from the standpoint of conservation that it has been largely superceded by more efficient methods.

mass and applied to fresh pulverized phosphate rock. The resultant product, known as double superphosphate or triple phosphate is much higher in available plant food content but requires considerable time for aging and also requires careful drying. Because of the greater cost of production the market price is much greater than that of ordinary superphosphate. Consequently, triple phosphate does not find favor with American farmers, who probably never understood the price

FIGURE 7.—Large-scale mining operations in the brown phosphate fields use draglines to remove overburden. Compare with Figure 6.

differential between the two products. Furthermore, triple phosphate tends to become gummy and sticky and is therefore difficult to apply.

The latest method of producing a phosphatic fertilizer from phosphate rock is a radical change from former methods and bids fair to produce equally radical changes in the future development and distribution of the industry. The major criticism of the present-day product, superphosphate, is the large bulk of inert material which it contains. As a result, it is felt that too large a portion of the cost of the finished product goes for bagging and for freight charges. A more concentrated fertilizer product is therefore highly desirable.

It is obvious that if the original tri-calcium phosphate of the phosphate rock contains a surplus of calcium in proportion to phosphoric acid, the addition of more phosphoric acid rather than the detraction of the surplus calcium by sulphuric acid is desirable. But, as has been explained, the production of free phosphoric acid by the use of a surplus of sulphuric acid has not proven satisfactory. Therefore the problem has been to devise some other method for producing large quantities of phosphoric acid at low cost.

The solution has been found in the electric-arc furnace. Prior to October, 1933, a series of experiments was conducted by the United States Bureau of Soils (W. H. Waggaman, Phosphorus in Fertilizer. U. S. Dept. Agric. Yearbook, 1920, Washington, D. C., 1921, pp. 217–233) and after that date by the Tennessee Valley Authority at Muscle Shoals, Alabama. It was found that if phosphate rock, silica, and coke were mixed and heated in an electric furnace the calcium in the tri-calcium phosphate of the rock would unite with the silica as slag and that free phosphorus would be volitalized. It was then only necessary to oxidize the phosphorus and hydrate it to produce phosphoric acid of from seventy to eighty per cent concentration. This, when mixed with pulverized phosphate rock dust, produces a triple phosphate which contained about forty-three per cent available plant food. (T.V.A. Annual Rept. and Appendices for the Fiscal Year Ended June 30, 1935, p. 20.) Improvements are still likely. Experimentally it has been possible to produce fertilizers containing over sixty per cent available plant food. Unlike the triple phosphate produced by the earlier excess-sulphuric acid method, it is not necessary to dry and age the finished product. Besides producing the new fertilizer the Tennessee Valley Authority in conjunction with state agricultural agencies is demonstrating to farmers the superiority of the new fertilizer over the old. This educa-

tional campaign bids fair to overcome the farmer-resistance to a slightly higher-priced product the superiority of which he does not comprehend.

The two far-reaching results of this new process are the reduction of costs and the utilization of deposits of rock too poor for use in the older methods. Costs are reduced through elimination of the expensive washing processes, since run-of-the-mine phosphate can be used, and through the great reduction of freight charges of the finished product. Many of the poorer phosphate deposits contain large quantities of silica, a worthless substance when the rock is used for superphosphate but an advantage in the electric-furnace process. Iron and aluminum compounds, the presence of which prohibits the use of the rock for superphosphate, present no problem to its use in the furnace. Therefore the introduction of this new method has in effect greatly increased the possible reserves of phosphate rock in Tennessee.

By the summer of 1939 two large plants utilizing the electric-furnace method were in operation. Plans for a third, to be constructed by the Tennessee Valley Authority on the brown phosphate fields near Franklin (Figure 1) and controlled by them, had been announced. The two plants already in operation, near Mt. Pleasant, produced only elemental phosphorus for the chemical trade. With small changes in their furnaces, however, they could produce the phosphoric acid to be used in triple phosphate fertilizer. The plans for the new plant near Franklin call for the production of fertilizer only. The Tennessee Valley Authority supplies the area with cheap hydroelectric power transmitted from Muscle Shoals, Alabama. Much of the rock of the brown phosphate fields furnishes sufficient silica, and coke is usually shipped from the coal fields near Birmingham, Alabama.

LANDSCAPE CHANGES IN THE PHOSPHATE LANDS

The mining of phosphate has not produced settlements in formerly unoccupied areas as have so many mining activities elsewhere. For the most part, mining in the phosphate lands was preceded by farming and today co-exists with it. However, mining has wrought a considerable number of changes in the area, in proportion to the extent to which it was carried on.

FIGURE 8.—Washer designed to remove clay and silica from brown phosphate rock. Piles of material in the foreground are phosphate rock and muck as they come from the mine.

In the white and the blue phosphate fields most farming is of the general type supplemented by livestock. Often this is at the subsistence level. If a cash crop is produced it is usually burley tobacco of indifferent quality. The country is rugged, of considerable relief, and in the early stages of maturity. Both roads and farms are divided between the ridge tops and the stream valleys with the intermediate slopes often uncleared or at best used only for pasture. As has been pointed out, the development of the phosphate deposits has been of limited extent. There has been plenty of room for both mine and farm; neither has encroached upon the other. Indeed mining, especially in the white phosphate fields, has

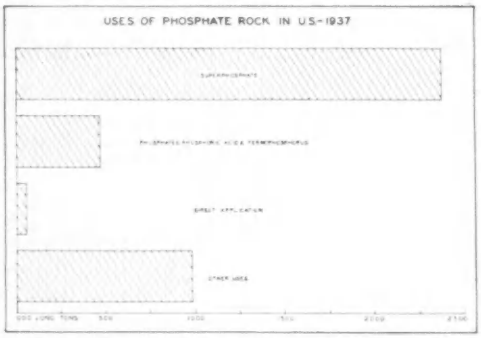

FIGURE 9.—Most of the phosphate rock mined in the United States is used as fertilizer. Superphosphate is one form. A small amount is applied directly and much of the portion labelled "other uses" is used in the production of triple phosphate.

been a valuable adjunct to farming for it has often provided the farmer with much needed off-season employment.

The brown phosphate fields present a contrasting picture, especially near Mt. Pleasant and Columbia, where mining is most extensive. Not only has the development of mining been greater than in the fields of white and blue phosphate, but also a far greater proportion of the area was in farm land prior to the beginning of mining operations. The area, a part of the Central Basin, is level to gently rolling. Originally corn and cotton, here as elsewhere in the southern part of the Basin, were the dominant crops. Natural bluegrass pasture formed the basis for an extensive livestock industry which even today makes the city of Columbia a famous mule market. Some of the changes wrought by mining are obvious and can be noted at a glance. Others are less obvious but perhaps of even greater significance.

One of the most obvious changes is the alteration of farm land by mining. What formerly was rolling cultivated land is now in mine dumps. It is too rough even for pasture and produces only a crop of weeds (Figure 10). From the ideal conservation standpoint this is undesirable; however, at present costs of labor and power, the cost of leveling an acre of mine dump area exceeds the price of the acre of land so leveled. And so the dumps remain. Some of the older mining operators, who have witnessed the improvement of mining methods which have permitted the use of poorer and poorer deposits and the reworking of old dumps with profit, are opposed to any attempt to return the land to farming. They point to a few areas, generally where hydraulic mining was used and therefore the surface left level. Now, after years of farming, these areas are being redug for phosphate that can be extracted in paying quantities by the new methods now used. Some even conclude that as long as the original limestone remains, the dumps should be left alone. This, however, seems a somewhat overly optimistic viewpoint since no method of making fertilizer, known at present, utilizes material of such low phosphate content.

Another alteration in the area which mining has produced is that in population distribution. Clustered about each mine are the buildings which house the workers. Each is a small community in itself (Figure 11). Most of these communities have no other reason save mining for their existence.

Inevitably the mines and the manufacturing connected with them enable the brown phosphate land to support a larger number of persons than it could do by agriculture alone. Labor which might otherwise have to compete for work on the farm finds employment in the mines or factories instead. Thus with the present small "boom" in phosphate due to the new electric-furnace method, farm labor near the phosphate fields was scarce during the summers of 1938 and 1939, W.P.A. rolls were reduced, and private charity was at a minimum.

FIGURE 10.—An abandoned mine dump near Mt. Pleasant. Note the track in the lower right formerly used to transport phosphate rock to the washer. Today this area is an unsightly producer of weeds.

This shortage of farm labor, so obvious now, has in reality existed in the area since the opening of the mines in the latter part of the nineteenth century. The result which this has produced is less obvious than those described above, but perhaps is of greater significance. With the shortage of labor has come the abandonment of the older clean-cultivated crops and the substitution of dairy herds for cotton as a cash producer for the farm. Thus, not only has the phosphate industry benefited the community by providing it with a more nearly balanced economy, mining and manufacturing as well as farming, but it has also indirectly aided a change in the major farm product of the community. The community could at best have been only a marginal producer of cotton owing to the shortness of the growing season. With its bluegrass pasture its present production of dairy commodities is far more desirable.

THE FUTURE

It is unusually difficult to make any forecast of the phosphate industry owing to the nature of the deposits, which makes an accurate estimation of reserves almost impossible, and to the recent change in the manufacturing side of the industry, which has caused by its greater efficiency so large an increase in the commercially workable reserves. Despite these difficulties certain general trends can be seen, however, and should be noted.

The relative amounts of reserve phosphate rock in the United States, of approximately fifty-five to sixty per cent B.P.L., are shown on Figure 12. It will be noted that the reserve of Tennessee, estimated at slightly over one hundred and three million long tons or less than two per cent of the total, is exceeded by that of Florida and is greatly exceeded by that of the western states of Idaho, Montana, Utah, and Wyoming. Of this Tennessee reserve, only about one-fifth or approximately twenty million long tons is of brown phosphate. (K. D. Jacobs et al. The Composition and Distribution of Phosphate Rock with Special Reference to the United States. U. S. Dept. Agric., Bur. Chem., Tech. Bull. No. 364, Washington, D. C., 1933, pp. 11 ff.) The remainder is blue, since the estimate of reserves does not include any white phosphate. It has been estimated that at the present average annual rate of production the brown phosphate reserves of Tennessee will probably last about forty years longer. (A. P. Haskell and O. E. Kiessling. Technology, Employment, and Output per Man in Phosphate-Rock Mining 1880–1937. W.P.A. Nat'l. Research Project,

FIGURE 11.—A line of houses near one of the brown phosphate mines which are the homes of the workers. The first building to the left is the company's store.

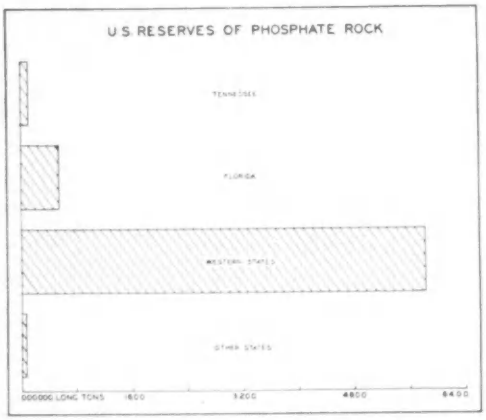

FIGURE 12.—Sources: Joint Committee of the Association of Land-Grant Colleges and Universities and of the Department of Agriculture; *Report on the Conservation and Use of Our National Phosphate Resources for the Permanent Benefit of the American People*, Houston, Texas, 1936; and K. D. Jacob, *Phosphate Rock Reserves of the United States*, 1938 Year Book, Commercial Fertilizer, Atlanta, Georgia, 1938.

Rept. No. E 7, Philadelphia, Pa., 1938, p. 92.) Then, if the industry continues to function in Tennessee, it will apparently be necessary to operate in the blue phosphate fields with their higher mining costs.

In the past our major fertilizer markets have been in our southern and middle Atlantic states, which has led to a heavy drain upon the phosphate lands of Tennessee and Florida. Today, the demand for phosphatic fertilizer is increasing, but not only in the states where the major markets have been, but in the states of the Middle and Far West. Thus, in the decade 1926–1936 the north central states increased their consumption of fertilizer seventeen per cent (U. S. Department of Agriculture, Agricultural Statistics 1938, Washington, D. C., 1938, p. 523), and the states of Washington, Oregon, and California increased theirs by one hundred and nine per cent. Most of this fertilizer is phosphatic. This increase in fertilizer demand, with the continuance of the practice of selling cash crops from the farms of these states and the emphasis placed on artificial fertilization by the Soil Conservation program of the United States Department of Agriculture, bids fair to continue. If it were necessary for the fields of Tennessee to supply this increased demand at the same rate it has supplied past demand, the reserves would probably not last as long as predicted.

Much of this increase in demand for phosphatic fertilizer, however, may be met in the future by an increase in the exploitation of the western field, thus relieving the Tennessee and Florida fields. These western fields are not only more extensive than the eastern but also have richer deposits. Their development to date has been slight owing to the long freight haul necessary to reach the major fertilizer markets. Possibility of the introduction of the electric-furnace method or the development of the somewhat similar blast-furnace method producing a more concentrated product better able to stand the cost of transportation, the western states can assume more nearly their share of production for the country. Already National and State governments have recommended such a development. (Phosphate Resources of the United States. Report of the Joint Congressional Committee to Investigate the Adequacy and Use of the Phosphate Resources of the United States, Senate Doc. No. 21, 76th Congress, 1st Session, Washington, D. C., 1939. Idaho Phosphate Commission and Idaho State Planning Board: Report on the Phosphate Conference Pocatello, Idaho. Oct. 8–9, 1937, n.d.) Upon this development as much as upon the amount of her reserves probably will depend the length of time during which the phosphate lands of Tennessee will continue production.

BOOK REVIEWS

ATWOOD, WALLACE W. *The Physiographic Provinces of North America.* Published by Ginn and Company, Boston, Massachusetts, 1940.

At the outset of this interesting and well-organized treatment, the author discusses the essentials of various classes of regions, and then makes clear the advantages of physiographic regions as the basic units of geographic study. The first chapter closes with a convincing exposition of interrelationships of physical features and life conditions.

The volume is presented as a textbook for college students and evidently presupposes some previous work in physiography or geology. The sequence of the regional discussions that follow the introductory chapter is progressively from east to west, from the Altantic and Gulf Coastal Plain and the Appalachian Highlands across the Central Plains, Great Plains, the Rockies, the Cordilleran Plateaus, to the Pacific Borderlands as the closing chapter. The Laurentian Upland is discussed following the presentation of the Appalachian Highlands and just preceding the chapter on the Central Lowlands.

On the whole the organization is largely a re-grouping of the provinces, regions, and subdivisions of the classification worked out by the committee headed by Fenneman a number of years ago. This is not only evidence of the soundness of Fenneman's classification and delineation of the regional units, it is also a testimonial of recognition of the scientific maturity that has been attained by regional physiography in the United States. Physiography has attained the status wherein its basic facts and philosophy are generally accepted by its professionals in the same degree as is true of other well-established sciences. This is a sign of healthy geographic progress, progress that should be sought in other phases of geographic science as well.

The text is fully illustrated by half-tones, color sketches, maps, and diagrams. A folded map of landforms of the United States prepared by Erwin Raisz deserves special mention; its clarity and artistry meet the standards expected from the masterly skill of the cartographer.

The general method followed throughout the treatment is consistently one of concise description followed by a summation of the evidence which serves as the basis for explanation of the origin and evolution of the existing landforms. The latter part of each unit presentation is devoted to the life occupance of the region under the caption, "An Approach to the Human Drama." This serves to give the book its unique aspect, a geographic motif as a fitting climax to the geomorphic discussion of each topographic region.

In the writer's opinion, a review should give the reader a faithfully depicted view of the field covered and the method of treatment used in the volume discussed. A review should not be synonymous with a critique. Nevertheless, I wish to add that geographers will surely welcome Doctor Atwood's book as a worthy contribution to the ever-growing realm of scientific geographic literature. The book is a college text, sound educationally as well as scientifically, and it will meet a demand that long has existed, a demand for a concise, well-organized exposition of the regional physiography of the United States.

NELS BENGTSON

MARSCHNER, FRANCIS J. *Rural Population Density in the Southern Appalachians.* U. S. Department of Agriculture, Miscellaneous Publication No. 367, March, 1940.

The large map of the Southern Appalachian region, which accompanies this bulletin, is unique in the detail with which it shows population density by means of contours and shading in ten shades of brown. It is apparent, upon comparing this map with one of land relief, that, in general, the contours of population approximate in location the contours of altitude, the lower lands, because more fertile and less rugged, being densely populated while the high mountain areas are almost devoid of people. But there are many exceptions. As the author explains:

"The densest rural population, with over a hundred inhabitants per square mile, is found almost exclusively in the valleys; but the locations of few if any of these dense-population areas are entirely attributable to a particularly favorable lay of the land combined with exceptional fertility of the soil for agricultural use. In the Allegheny and Cumberland Plateaus, the narrow, densely-populated valleys are primarily coal-mining centers, while for the rest of the area, they represent the industrial, suburban, or village type of settlement.

"For the intermediate density classes often no such close, direct relationship can be detected between population density and the advantages and disadvantages of the natural environment. Degree of roughness of surface relief or soil fertility is by no means consistently represented by corresponding population-density classes. Economic and social factors inject themselves

into the situation and complicate the reciprocal relationship between man and nature. The historical background of settlement is another factor that has influenced population density in some places more than in others. Moreover, a traditional attitude of the people in their preference for environmental features undoubtedly accounts for and explains, to some extent, the location of settlement in comparatively poor situations. Nonconformities of population density as related to the natural advantages and disadvantages of the landscape are the result."

This Southern Appalachian region has the highest birth rate and the densest population relative to natural resources of any part of the United States. In some counties the birth rate is so high that population would double in a quarter-century were there no migration. The author of the bulletin comments on this condition as follows:

"In parts of the more-or-less secluded hill and mountain recesses in the Southern Appalachians, untouched by the arteries of travel and communication, a relatively dense population has backed up on the land in unfavorable natural surroundings. Because the people are dependent primarily on agriculture for a living, intensive land use is resorted to on land that is poorly adapted to arable farming. Cultivation of the steep hillsides provides bare subsistence for many of the inhabitants, often at a declining rate of return owing to the reduction in yield that accompanies the depletion of the soil through erosion. Accustomed to a comparatively low standard of living, with little or no means or opportunity for education and training, many of the youth of these areas are handicapped. They face three possible but unfavorable alternatives: Clearing of more land on the mountainsides, increasing the surplus of unskilled labor, or moving on to settle as tenants on other poor land. Migration to better lands of higher price is deterred by the difficulties of accumulating capital. Thus, maladjustment in land use is not only perpetuated but is likely to be aggravated.

"There are also factors that operate in the opposite direction. One of these, modern technical development, has contributed to the restriction of population density on land well suited to general farming. Obviously, one of the qualifications for such land is sufficient smoothness of surface relief to permit the employment of modern farm machinery and implements. The use of farm machinery increases the efficiency of man labor tremendously, and enables the operator to cultivate and utilize effectively a much larger acreage than could be utilized without it. As a result, the size of the family farm can be correspondingly larger where mechanical production methods are possible. Such farms represent a considerable capital investment, and with their equipment in the form of buildings, machinery, and implements adjusted to the size of the farm, are encumbered with a commitment that will tend to keep them intact as operating units."

This is one of the best bulletins dealing with the relation of population to natural resources and use of the land, which the Federal Government has ever issued. The map is especially valuable and constitutes a notable contribution to the progress of cartography in the United States.

O. E. BAKER

WASHINGTON STATE PLANNING COUNCIL. *Cascade Mountains Study.* Olympia, Washington, 1940.

Because of interest in the wise management of land within Washington and concern over reports to the effect that a large acreage of national forest land in the Washington Cascades might be transferred to the National Park Service, the State Planning Council initiated this study of resources in that region. Inasmuch as areas under the jurisdiction of the National Park Service are restricted to recreational use and those under the supervision of the National Forest Service are operated under the principle of multiple use, allowing the forest values (timber, watershed, wild life, grazing, recreation) to be utilized by individuals and companies under restriction, the Council had been urged by state officials and private citizens to study the facts pertaining to the lands subject to transfer and decide under which of the two government agencies they could be managed as to best affect the economy and life of the state and nation.

To determine accurately their value, the Council made the national forests of the Washington Cascades a study area and appointed five citizens to an advisory committee to assist it in an evaluation of the kind, amount, and utilization of resources therein. The *Cascade Mountains Study* is the report made by the committee after it had examined all published data, made personal inspection of the area, consulted with informed agencies and individuals, and held public meetings at seven cities on the margins of the Cascades.

The first three chapters contain discussions of the differing policies of the National Park and Forest Services, a report of the advisory committee, and a summary of the findings and recommendations of the State Planning Council. As the Council recommends that the lands remain under the jurisdiction of the National Forest Service to be further developed and managed on the principle of multiple use, proponents of a park have criticized the book, the United States Secretary of the Interior declaring it to be "fifty-six pages of nothing new."

A fourth chapter discloses an interesting pattern of land ownership in the study area. Practically all of the northern third is in federal

ownership. The outstanding feature of the middle third is the checkerboard pattern of the intermingling private (largely Northern Pacific property acquired by land grant) and federal holdings. In the southern third this same intermingling of private and public ownership occurs along the western and eastern sides of the national forests, leaving the interior solidly under federal control.

The remaining nine chapters are of special value to geographers for they contain amplified discussions of the physiography, climatology, and water, forest, mineral, wild life, recreational, and grazing resources of the region, as well as of its railroads, highways and trails.

The report, fortified with twenty-seven tables and replete with maps (population, elevations, ownership, isohyetal, water resources, forests, wild life and recreation, Snoqualmie National Forest trail camps, grazing, and transportation) and well-selected illustrations, contains a large amount of valuable information on the Cascade Mountains of Washington that is greatly needed by geographers who teach Conservation of Natural Resources and Geography of North America. Regional geographers may regret that the boundaries of the study area do not coincide with those of the physiographic region within the state, but such a survey was not necessary, was beyond the objectives of the planning council and its advisory committee, and might not have increased greatly the value of the report, for the five national forests and Mount Ranier National Park occupy a very large part of the Cascade Mountains of Washington.

R. M. SHAW

WHITTLESEY, DERWENT. *The Earth and the State: A Study of Political Geography.* xvii and 618 pp. Henry Holt and Company, Inc., New York, 1939. Price $5.00.

This book is without counterpart although it might superficially be grouped with Ratzel's "Politische Geographie" and Semple's "Influences of Geographic Environment." It makes a unique contribution clearly reflecting the trained historian who has mastered geography. It seeks to lift political geography from a morass of speculation to a foundation of field observation. The findings of history, archaeology, and economic and regional geography, supplemented by two decades of personal field investigation in five continents, have resulted in this pregnant treatise of penetrating geopolitical insight and philosophical depth. The book successfully expresses the degree of correspondence existing between the structure of states and the structure of their natural environments. Where facts permit, it shows how the characters of states are in many instances intimately bound to the earth conditions in which they evolved. Finally, it is shown how political systems and legal concepts that express them are not confined to the region of their origin but may spread to other areas and so create some degree of political uniformity over contrasting environments. By a wealth of historical, political, and regional examples the threadbare accusations of environmental determinism and hasty generalization leveled at American geography are refuted.

The world stage for regional geopolitical analysis is set with discussions of: the concept of the "ecumene" or the populous nuclear core of the state; the importance of internal communication and transportation to the vitality of statehood; size versus form for the ideal state; arable land, minerals, and crop resources, and the laws governing their localization; and finally, oceans as international areas, involving the historical reorientation of the continents to face the sea, islands as springboards of overseas expansion, and rivers as avenues of colonial penetration. Following this the book deals with specific nations or continental groupings of nations: Britain as a coastland state and world power; France as the archetype of the occidental national state; Germany as a conflict of maritime and interior interests; East Central Europe as exemplified by the cohesive effect of its capitals; the unity of the Mediterranean realm and the geopolitical structure of Italy; Africa as an exploitable and exploited continent; the geopolitical antithesis of Latin and English America; the swift envelopment and compartmentization of Latin America with a discussion of its boundaries and capitals; and the growth and character of the geopolitical structure of North America. Finally, there is a discussion of earth conditions which have made their impress on political thought as exemplified by the contrasting legal systems; and a philosophical summary of political geography.

Though it is difficult to differentiate between the relative value of various portions of this book, the contribution made by chapters on the state and communication, on Africa, and finally, on the development of France as a national state, are worthy of special note. The following quotations on France serve to illustrate the character of the book and in the light of recent events they seem truly prophetic.

"The compact territory north of the Pyrenees and west of the Alps–Jura–Vosges–Ardennes tends to become politically unified. No less does each of the major river basins—Rhone, Garonne, Loire, Seine, and Moselle–Meuse—tend to assert its independence. . . . That part played by the nuclear Paris Basin in the long struggle to weld the lowlands into a single state has been crowned by a radial pattern of communication lines which is both the expression and the symbol of Paris as the hub of France . . . it would be flying in the face of the long view of history to assert that French solidarity, forged of diverse regions, is invincible. It may be safe to expect that it will endure so long as the emotion of patriotism is identified

with that group of physical units which we call France, and so long as the area wields the power to maintain its independence of potential enemies."

MALCOLM J. PROUDFOOT

TOMPKINS, STUART RAMSAY. *Russia Through the Ages.* Published by Prentice-Hall, Inc., New York, 1940.

Few geographers, particularly those interested in the fields of Human Geography, are adequately grounded in history, and this becomes peculiarly so when the geography of Russia is considered. The historical background of this great country, and of the multiplicity and diversity of peoples which constitute its folk, are relatively unknown to the geographers of America, and they find considerable difficulty in authoritatively and adequately interpreting the character of Russian culture or Russian economy, unless they can have reference to some authoritative and fairly complete treatise on Russian history. The need of our geography of Russia has been more satisfactory relationship of its history to the evolution of its culture and its sovereignty.

This need is now happily filled by "Russia Through the Ages" which embraces the long history of Russia from the Scythians to the Soviets, by Dr. Stuart R. Tompkins. It is comprehensive enough to present significant details; it is accurate enough to be trustworthy in its facts; it is brief enough to avoid monotony and drudgery in using its material. Its text, well illustrated by outline maps and pertinent illustrations, numbers 700 pages. Its glossary, its chronological table of Russian history, and most of all, its almost sixty pages of references, a reasonably complete bibliography; all these contribute to its value for the geographer and for the layman.

It is a book well worth adding to one's library in these days of international associations and interests. Russia is one of the major factors in the world's economy, in the world's political and social progress; it behooves our people to learn something more of its history than they have known heretofore. This book enables them to do so easily and with assurance of accuracy and clarity.

W. E. E.

GEISE, JOHN. *Man and the Western World.* Published by Harcourt, Brace and Company, New York, 1940.

This book, more than a thousand pages of text, map, and illustration, constitutes a valuable summary of history in its relation to the western world. Part I, on Origins, treats of the foundations of civilization in the preliterary period; Part II, on The Ancient Oriental World, of archaic civilization, and ancient imperial civilization; Part III, on The Classical Mediterranean World, of the foundation of Mediterranean civilizations, the civilization of the Greeks, and Roman civilization; Part IV, on The Transition to Medievalism, of the rise of the church and the fall of Rome, non-western civilization in the Middle Ages, and the origins of western civilization; Part V, on Western Civilization in the Middle Ages, of the medieval social pattern, the medieval church and medieval culture, and town life and the origins of the European middle class.

The second half of the book, Parts VI, on the Transition to Modernity, is concerned with the break-up of the medieval pattern and the renaissance, nationalism and the Protestant revolt, and the commercial revolution, capitalism, and modern science; VII, on The Modern World, with dynastic states and colonial empires, and the Age of Reason; VIII, on Revolution, with the industrial revolution, and middle class revolution and economic liberalism; and finally IX, on The Contemporary World Takes Form, with the height of nationalism and democracy, contemporary civilization, imperialism and the world war, and between two wars.

All these several parts and topics have been thus listed because they reveal, better than pages of text, the composition and character of the material treated, and give some clue to the point of view. The book yields a fundamental concept of the development of culture and ethnic characteristics that every man needs to have; though the philosophy back of the interpretation may prove untenable with the course of years, the book will lose none of its value as a reference, and as an exposition of the method of approach in a definite period of historical interpretation.

W. E. E.

WILGUS, A. CURTIS, AND D'ECA, RAUL. *An Outline History of Latin America.* Published by Barnes & Noble, Inc., New York, 1939.

Rather too brief for satisfactory and authoritative reference, this little book on the history of Latin America provides an outline of history of that region that will prove particularly valuable to geographers, economists, and others who are not specifically concerned with historical chronology and historical interpretation. The book is just what it purports to be, an outline, conveniently divided into three parts—I, Colonial Latin America; II, The Revolution for Independence; and III, Latin America Since Independence.

With ever-growing interest in Latin America, and constantly increasing relations with the nations that it comprises, such a book as this is an invaluable reference for every historian, geographer, and economist.

W. E. E.